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THE DEVELOPMENT OF POLITICAL INSTITUTIONS.

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II.—POLITICAL ORGANIZATION IN GENERAL.

THE mere gathering of individuals into a group does not constitute them a society. A society, in the sociological sense, is formed only when, besides juxtaposition, there is coöperation. So long as members of the group do not combine their energies to achieve some common end or ends, there is little to keep them together. They are prevented from separating only when the wants of each are better satisfied by uniting his efforts with those of others than they would be if he acted alone.

Coöperation, then, is at once that which can not exist without a society, and that for which a society exists. It may be a joining of many strengths to effect something which the strength of no single man can effect; or it may be an apportioning of different activities to different persons, who severally participate in the benefits of one another's activities. The motive for acting together, originally the dominant one, may be defense against enemies; or it may be the easier obtainment of food, by the chase or otherwise; or it may be, and commonly is, both of these. In any case, however, the units pass from the state of perfect independence to the state of mutual dependence; and as fast as they do this they become united into a society rightly so called.

But coöperation implies organization. If acts are to be effectually combined, there must be arrangements under which they are adjusted in their times, amounts, and characters.

This social organization, necessary as a means to concerted action, is of two kinds. Though these two kinds generally coexist, and are

more or less interfused, yet they are distinct in their origins and natures. There is a spontaneous coöperation which grows up without thought during the pursuit of private ends; and there is a coöperation which, consciously devised, implies distinct recognition of public ends. The ways in which the two are respectively established and carried on present marked contrasts.

Whenever, in a primitive group, there begins that coöperation which is effected by exchange of services—whenever individuals find their wants better satisfied by giving certain products which they can make best in return for other products they are less skilled in making, or not so well circumstanced for making—there is initiated a kind of organization which then, and throughout its higher stages, results from endeavors to meet personal needs. The division of labor, to the last as at first, grows by experience of mutual facilitations in living. Each new specialization of industry arises from the effort of one who commences it to get profit, and establishes itself by conducing in some way to the profit of others. So that there is a kind of concerted action, with the elaborate social organization developed by it, which does not originate in deliberate concert. Though it is true that within the small subdivisions of this organization we find everywhere repeated the relation of employer and employed, of whom the one directs the actions of the other; yet this relation, spontaneously formed in the pursuit of private ends and continued only at will, is not made with conscious reference to achievement of public ends: ordinarily these are not thought of. And though, for the regulating of trading activities, there eventually arise agencies serving to adjust the supplies of commodities to the demands; yet such agencies do this not by direct stimulations or restraints, but simply by communicating information which serves to stimulate or restrain; and, further, these agencies themselves grow up not for the intended purpose of thus regulating, but in the pursuit of gain by individuals. So unintentionally has there arisen the elaborate division of labor by which production and distribution are now carried on, that only in modern days has there come a recognition of the fact that it has all along been arising.

On the other hand, that coöperation which unites the actions of individuals for a purpose immediately concerning the whole society, is a conscious coöperation, and is carried on by an organization of another kind, arising in a different way. When the primitive group has to defend itself against other groups, its members act together under further stimuli than those constituted by purely personal desires. Even at the outset, before any control by a chief exists, there is the control exercised by the group over its members; each of whom is obliged, by the *consensus* of opinion, to join in the general defense. Very soon the warrior of recognized superiority begins to exercise over each, during war, an influence additional to that exercised by the opinion of the group; and, when his authority becomes established, it

greatly furthers combined action. From the beginning, therefore, this kind of social coöperation is a conscious coöperation, and a coöperation which is not wholly a matter of choice—is often much at variance with private wishes. As the organization initiated by it develops, we see that, in the first place, the fighting division of the society displays in a more marked degree these same traits; the grades and divisions constituting an army coöperate more and more under a regulation, consciously established, of agencies which override individual volitions—or, to speak strictly, control individuals by motives which prevent them from acting as they would spontaneously act. In the second place, we see that, throughout the society as a whole, there spreads a kindred form of organization—kindred in so far that, for the purpose of maintaining the militant organization and the government which directs it, there are similarly established over citizens agencies which force them to labor more or less largely for public ends instead of private ends. And, simultaneously, there develops a further organization, still akin in its fundamental principle, which restrains individual activities in such wise that social safety shall not be endangered by the disorder consequent on unchecked pursuit of personal ends. So that this kind of social organization is distinguished from the other, as arising through conscious pursuit of public ends, in furtherance of which individual wills are constrained, first of all by the joint wills of the entire group, and afterward more definitely by the will of a regulative agency which the group evolves.

Most clearly shall we perceive the contrast between these two kinds of organization on observing that, while they are both instrumental to social welfare, they are instrumental in converse ways. That organization shown us by the division of labor for industrial purposes exhibits combined action; but it is a combined action which directly seeks and subserves the welfares of individuals, and indirectly subserves the welfare of society as a whole by preserving individuals. Conversely, that kind of organization evolved for governmental and defensive purposes exhibits combined action; but it is a combined action which directly seeks and subserves the welfare of the society as a whole, and indirectly subserves the welfares of individuals by preserving the society. Efforts for self-preservation by the units originate the one form of organization; while efforts for self-preservation by the aggregate originate the other form of organization. In the one case there is conscious pursuit of private ends only; and the correlative organization resulting from this pursuit of private ends, growing up unconsciously, is without coercive power. In the other case there is conscious pursuit of public ends; and the correlative organization, consciously established, exercises coercion.

Of these two kinds of coöperation and the structures effecting them, we are here concerned only with one. Political organization is to be understood as that part of social organization which consciously carries

on directive and restraining functions for public ends. It is true, as already hinted, and as we shall see presently, that the two kinds are mingled in various ways—that each ramifies through the other more or less according to their respective degrees of predominance. But the two are essentially different in origin and nature; and for the present we must, so far as may be, limit our attention to the last.

That the coöperation into which men have gradually risen secures to them benefits which could not be secured while, in their primitive state, they acted singly, and that, as an indispensable means to this coöperation, political organization has been, and is, advantageous, we shall see on contrasting the states of men who are not politically organized with the states of men who are politically organized in less or greater degrees.

There are, indeed, conditions under which as good an individual life is possible without political organization as with it. Where, as in the habitat of the Esquimaux, there are but few persons, and these very widely scattered; where there is no war, probably because the physical impediments to it are great and the motives to it feeble; and where circumstances make the occupations so uniform that there is little scope for the division of labor—mutual dependence can have no place, and the arrangements which effect it are not needed. Recognizing this exceptional case, let us consider the cases which are not exceptional.

The Digger Indians, "very few degrees removed from the orang-outang," who, scattered among the mountains of the Sierra Nevada, sheltering in holes and living on roots and vermin, "drag out a miserable existence in a state of nature, amid the most loathsome and disgusting squalor," differ from the other divisions of the Shoshones by their entire lack of social organization. The river-haunting and plain-haunting divisions of the race, under some, though but slight, governmental control, lead more satisfactory lives. In South America the Chaco Indians, low in type as are the Diggers, and like them degraded and wretched in their lives, are similarly contrasted with the superior and more comfortable savages around them in being dissociated. Among the Bedouin tribes, the Sherarat are unlike the rest in being divided and subdivided into countless bands which have no common chief; and they are described as being the most miserable of the Bedouins. More decided still is the contrast noted by Baker between certain adjacent African peoples. Passing suddenly, he says, from the unclothed, ungoverned tribes—from the "wildest savagedom to semi-civilization"—we come in Unyoro to a country governed by "an unflinching despot," inflicting "death or torture" for "the most trivial offenses"; but where they have developed administration, sub-governors, taxes, good clothing, arts, agriculture, architecture. So, too, concerning New Zealand when first discovered, Cook remarks that there seemed to

be greater prosperity and populousness in the regions subject to a king.

These last cases introduce us to a further truth. Not only does that first step in political organization which places individuals under the control of a tribal chief bring the advantages gained by better coöperation, but such advantages are increased when minor political heads become subject to a major political head. As typifying the evils which are thereby avoided, I may name the fact that among the Belooches, whose tribes, unsubordinated to a general ruler, are constantly at war with one another, it is the habit to erect a small mud-tower in each field, where the possessor and his retainers guard his produce—a state of things allied to, but worse than, that of the Highland clans, with their strongholds for sheltering women and cattle from the inroads of their neighbors, in days when they were not under the control of a central power. The benefits derived from such wider control, whether of a simple head or of a compound head, were felt by the early Greeks when the Amphictyonic Council established the laws that "no Hellenic tribe is to lay the habitations of another level with the ground; and from no Hellenic city is the water to be cut off during a siege." The good which results from that advance of political structure which unites smaller communities into larger ones was shown in our own country when, by the Roman conquest, the incessant fights between tribes were stopped; and again, in later days, when feudal nobles, becoming subject to a monarch, were debarred from private wars. Under its converse aspect, we see the same truth when, amid the anarchy which followed the collapse of the Carlovingian empire, princes and barons, resuming their independence, became active enemies to one another: their state being such that "when they were not at war they lived by open plunder." And the history of Europe has repeatedly, in many places and times, furnished kindred illustrations.

While political organization, as it extends itself throughout masses of increasing size, directly furthers welfare by removing that impediment to coöperation which the antagonism of individuals and of tribes causes, it indirectly furthers it in another way. Nothing beyond a rudimentary division of labor can arise in a small social group. Before commodities can be multiplied in their kinds, there must be multiplied kinds of producers; and, before each commodity can be produced in the most economical way, the different stages in the production of it must be apportioned out among special hands. Nor is this all. Neither the required complex combinations of individuals, nor the elaborate mechanical appliances which facilitate manufacture, can arise in the absence of a large community, generating a great demand.

But though the advantages gained by coöperation presuppose political organization, this political organization necessitates disadvantages;

and it is quite possible for these disadvantages to outweigh the advantages. The controlling structures have to be maintained, and the restraints they impose have to be borne; and the evils inflicted by taxation and by tyranny may become greater than the evils prevented.

Where, as in the East, the rapacity of monarchs has sometimes gone to the extent of taking from cultivators so much of their produce as to have afterward to return part for seed, we see exemplified the truth that the agency which maintains order may cause miseries greater than the miseries caused by disorder. The state of Egypt under the Romans, who, on the native set of officials, superposed their own set, and who made drafts on the country's resources not for local administration only but also for imperial administration, furnishes an instance. Beyond the regular taxes there were demands for feeding and clothing the military, wherever quartered; extra calls were continually made on the people for maintaining public works and subaltern agents; men in office were themselves so impoverished by exactions that they "assumed dishonorable employments or became the slaves of persons in power; gifts made to the government were soon converted into forced contributions; and those who purchased immunities from extortions found them disregarded as soon as the sums asked had been received. More marked still were the curses following excessive development of political organization in Gaul during the decline of the Roman Empire:

> So numerous were the receivers in comparison with the payers, and so enormous the weight of taxation, that the laborer broke down, the plains became deserts, and woods grew where the plow had been. . . . It were impossible to number the officials who were rained upon every province and town. . . . The crack of the lash and the cry of the tortured filled the air. The faithful slave was tortured for evidence against his master, the wife to depose against her husband, the son against his sire. . . . Not satisfied with the returns of the first enumerators, they sent a succession of others, who each swelled the valuation—as a proof of service done; and so the imposts went on increasing. Yet the number of cattle fell off, and the people died. Nevertheless, the survivors had to pay the taxes of the dead.

And how literally in this case the benefits were exceeded by the mischiefs is shown by the remark that "they fear the enemy less than the tax-gatherer: the truth is, that they fly to the first to avoid the last. Hence, the one unanimous wish of the Roman populace, that it was their lot to live with the barbarian."

In the same regions during later times the lesson was repeated. While internal peace and its blessings were achieved in mediæval France as fast as feudal nobles became subordinate to the king—while the central power, as it grew stronger, put an end to that primitive practice of a blood-revenge which wreaked itself on any relative of an offender, and made the "truce of God" a needful mitigation of the universal savagery; yet from this extension of political organization there presently grew up evils as great or greater—multiplication of

taxes, forced loans, groundless confiscations, arbitrary fines, progressive debasements of coinage, and a universal corruption of justice consequent on the sale of offices: the results being that many people died by famine, some committed suicide, while others, deserting their homes, led a wandering life. And then, afterward, when the supreme ruler, becoming absolute, controlled social life in all its details, through an administrative system vast in extent and ramifications, with the general result that in less than two centuries the indirect taxation alone "crossed the enormous interval between eleven millions and three hundred and eleven millions," there came the national impoverishment and misery which resulted in the great Revoultion.

Even the present time supplies kindred evidence, in sundry places. A voyage up the Nile shows every observer that the people are better off where they are remote from the center of government—where administrative agencies can not so easily reach them. Nor is it only under the barbaric Turk that this happens. Notwithstanding the boasted beneficence of our rule in India, the extra burdens and the complication of restraints it involves have the effect that the people find some of the adjacent countries preferable; the ryots in sundry places are leaving their homes and settling in the territory of the Nizam and in Gwalior.

Not only do those who are controlled suffer, from political organization, evils which greatly deduct from, and sometimes exceed, the benefits. Numerous and rigid governmental restraints shackle those who impose them as well as those on whom they are imposed. The successive grades of ruling agents, severally coercing grades below, are themselves coerced by grades above; and even the very highest ruling agent is enslaved by the system created for the preservation of his supremacy. In ancient Egypt the daily life of the king was minutely regulated alike as to its hours, its occupations, its ceremonies; so that, nominally all-powerful, he was really less free than a subject. It has been, and is, the same with other despotic monarchs. Till lately, in Japan, where the form of organization had become fixed, and where, from the highest to the lowest, the actions of life were prescribed in detail, the exercise of authority was so burdensome that voluntary resignation of it was frequent. Adams writes, "The custom of abdication is common among all classes, from the Emperor down to his meanest subject." European states have examplified this reacting tyranny. "In the Byzantine palace," says Gibbon, "the Emperor was the first slave of the ceremonies he imposed." Concerning the tedious court life of Louis le Grand, Madame de Maintenon remarks: "Save those only who fill the highest stations, I know of none more unfortunate than those who envy them. If you could only form an idea of what it is!"

So that, while the satisfaction of men's personal wants is furthered both by the maintenance of order and by the formation of aggregates

large enough to permit extensive division of labor, it is hindered both by deductions, often very great, from the products of their actions, and by the restraints imposed on their actions, usually in excess of the needs. And political control indirectly entails evils on those who exercise it as well as on those over whom it is exercised.

The stones composing a house can not be otherwise used until the house has been pulled down. If the stones are united by mortar, there must be extra trouble in destroying their present combination before they can be recombined. And if the mortar has had centuries in which to consolidate, the breaking up of the masses formed is a matter of such difficulty that building with new materials becomes more economical than rebuilding with the old.

I name these facts to illustrate the truth that any kind of arrangement stands in the way of rearrangement; and that this must be true of organization, which is one kind of arrangement. When, during the evolution of a living body, its component substance, at first relatively homogeneous, has been transformed into a combination of heterogeneous parts, there results an obstacle, always great and often insuperable, to any considerable change of structure; the more elaborate and definite the structure the greater is the resistance it opposes to alteration. And this, which is conspicuously true of an individual organism, is true, if less conspicuously, of a social organism. Though a society, composed of discrete units, and not having had its type fixed by inheritance from countless like societies, is much more plastic, yet the same principle holds. As fast as its parts are differentiated—as fast as there arise classes, bodies of functionaries, established institutions—these, becoming coherent within themselves and with one another, resist such forces as tend to modify them. The conservatism of every long-settled institution daily exemplifies this law. Be it in the antagonism of a Church to legislation interfering with its arrangements; be it in the opposition of an army to abolition of the purchase system; be it in the disfavor with which the legal profession at large has regarded law reform—we see that neither in their structures nor in their modes of action are parts that have once been specialized easily changed.

As it is true of a living body that its various acts have as their common end self-preservation, so is it true of its component organs that they severally tend to maintain themselves in their integrity. And, similarly, as it is true of a society that maintenance of its existence is the aim of its combined actions, so it is true of its separate classes and systems of officials, or other specialized parts, that the dominant aim of each is to preserve itself. Not the function to be performed, but the sustentation of those who perform the function, becomes the object in view: the result being that when the function is needless, or even detrimental, the structure still preserves itself as long as it can. In early days the history of the Knights Templars

furnished an illustration of this tendency. Down to the present time we have before us the familiar instance of trade guilds in London, which, having ceased to perform their original functions, nevertheless jealously maintain themselves for no purpose but the gratification of their members. And the accounts given in "The Black-book," of the sinecures which survived up to recent times, yield multitudinous illustrations.

The extent to which an organization resists reorganization we shall not fully appreciate until we observe that its resistance increases in a compound progression. For, while each new part is an additional obstacle to change, the formation of it implies a deduction from the forces causing change. If, other things remaining the same, the political structures of a society are further developed—if the existing institutions are extended or fresh ones set up—if, for directing social activities in greater detail, extra staffs of officials are appointed, the simultaneous results are an increase in the aggregate of those who form the regulating part and a corresponding decrease in the aggregate of those who form the part regulated. In various ways all who compose the controlling and administrative organization become united with one another and separated from the rest. Whatever be their particular duties, they are similarly related to the minor and major governing centers of their departments, and, through them, to the supreme governing center; and are habituated to like sentiments and ideas respecting the set of institutions in which they are incorporated. Receiving their subsistence through the national revenue, they tend toward kindred views and feelings respecting the raising of such revenue. Whatever jealousies there may be between their divisions, are overridden by sympathy when any one division has its existence or privileges endangered, since the interference with one division may spread to others. Moreover, they all stand in like relations to the rest of the community, whose actions are in one way or other superintended by them; and hence are led into kindred views respecting the need for such superintendence and the propriety of submitting to it. No matter what their previous political opinions may have been, they can not become public agents of any kind without being biased toward opinions congruous with their functions. So that, inevitably, each further growth of the instrumentalities which control, or administer, or inspect, or in any way direct social forces, increases the impediment to future modifications, both positively, by strengthening that which has to be modified, and negatively, by weakening the remainder; until at length the rigidity becomes so great that change is impossible and the type becomes fixed.

Nor does each further development of the regulative organization increase the obstacles to change only by relatively increasing the power of those who, as regulators, maintain the established order, and decreasing the power of those who, as the regulated, have not the same

direct interests in maintaining it. For the ideas and sentiments of a community as a whole progressively adapt themselves to the *régime* familiar from childhood, in such wise that it comes to be looked upon as natural, and as the only thing possible. In proportion as public agencies occupy a larger space in daily experience, leaving but a smaller space for other agencies, there comes a greater tendency to think of public control as everywhere needful, and a less ability to conceive of activities as otherwise controlled. At the same time the sentiments, adjusted by habit to the regulative machinery, become enlisted on its behalf, and adverse to the thought of a vacancy to be made by its absence. In brief, the general law, that the social organism and its units act and react in such ways as to become congruous, implies that every further extension of political organization increases the obstacle to reorganization, not only by increasing the strength of the regulative part and decreasing the strength of the part regulated, but also by producing in citizens thoughts and feelings in harmony with the resulting structure, and out of harmony with anything substantially different. Both France and Germany furnish examples of this truth. M. Comte, while looking forward to an industrial state, was so swayed by the ideas and sentiments appropriate to the French form of society, that his scheme of organization for the industrial state prescribes its arrangements with a definiteness and detail characteristic of the militant type, and utterly at variance with the industrial type. Indeed, he had a profound aversion to that individualism which is a product of industrial life and gives the character to industrial institutions. So, too, in Germany, we see that the Socialist party, who are regarded and who regard themselves as wishing to entirely reorganize society, are so incapable of really thinking away from the social type under which they have been born and nurtured, that their proposed social system is in essence nothing else than a new form of the system they would destroy. It is a system under which life and labor are to be arranged and superintended by public instrumentalities, omnipresent like those which already exist and no less coercive, the individual having his life even more regulated for him than now.

While, then, on the one hand, in the absence of settled arrangements, there can not be coöperation, yet coöperation of a higher kind is hindered by the arrangements which facilitate coöperation of a lower kind. Though, without some established relations among parts, there can be no combined actions, yet, the more extensive and elaborate such relations grow, the more difficult does it become to make an improved combination of actions. There is an increase of the forces which tend to fix, and a decrease of the forces which tend to unfix; until the fully-structured social organism, like fully-structured individual organism, becomes no longer adaptable.

In a living animal, formed as it is of aggregated units originally

like in kind, the progress of organization implies, not only that the units composing each differentiated part severally maintain their positions, but also that their progeny succeed to those positions. Bile-cells which, while performing their functions, grow and give origin to new bile-cells, are, when they decay and disappear, replaced by these: the cells descending from them do not migrate to the kidneys, or the muscles, or the nervous centers, to join in the performance of their duties. And, evidently, unless the specialized units each organ is made of gave origin to units similarly specialized, which remained in the same place, there could be none of those settled relations among parts which characterize the organism and fit it for its particular mode of life.

In a society, also, fixity of structure is favored by the transmission of positions and functions through successive generations. The maintenance of those class-divisions which arise as political organization advances implies the inheritance of a rank and a place in each class. Obviously, in proportion as the difficulty of rising from one grade into another is great, the social grades become settled in their relations. The like happens with those subdivisions of classes which, in some societies, constitute castes, and in other societies are partially exemplified by guilds. Where custom or law compels the sons of each trader to follow his father's occupation, there result, among the structures carrying on production and distribution, obstacles to change analogous to those which result in the regulative structures from impassable divisions of ranks. India shows this in an extreme degree; and in a less degree it was shown by the craft-guilds of early days in England, which facilitated adoption of a craft by the children of those engaged in it, and hindered adoption of it by others. Thus we may call inheritance of position and function the principle of fixity in social organization.

There is another way in which succession by inheritance, whether to class-position or to occupation, conduces to stability. It secures supremacy of the elder; and supremacy of the elder tends toward maintenance of the established order. A system under which a chief-ruler, sub-ruler, head of a clan or house, official, or any person having the power given by rank or property, has his place filled up at death by a descendant, in conformity with some accepted rule of succession, is a system under which, by implication, the young, and even the middle-aged, are excluded from the conduct of affairs. So, too, where an industrial system is such that the son, habitually brought up to his father's business, succeeds to his position when he dies, it follows in like manner that the regulative power of the elder over the processes of production and distribution is scarcely at all qualified by the power of the younger. Now, it is a truth daily exemplified that increasing rigidity of organization, necessitated by the process of evolution, produces in age an increasing strength of habit and aversion to change.

Hence it results that succession to place and function by inheritance, having as its necessary concomitant the monopoly of power by the eldest, involves a prevailing conservatism; and this further insures maintenance of things as they are.

Conversely, social change is facile in proportion as men's positions and functions are determinable by personal qualities. If, not being prevented by law or custom, members of one rank establish themselves in another rank, they in so far directly break the division between the ranks; and they indirectly weaken the division by preserving their family relations with the first, and forming new ones with the second; while, further, the ideas and sentiments prevailing in the two ranks, previously more or less different, are made to qualify one another and to modify the characters of their members. Similarly, if between subdivisions of the producing and distributing classes there are no barriers to migration, then, in proportion as migrations are numerous, influences physical and mental, following interfusion, tend to alter the natures of their units; at the same time that they perpetually check the establishment of differences of nature, caused by differences of function. Such transpositions of individuals between class and class, or group and group, must, on the average, however, be determined by the fitnesses of the individuals for their new places and duties. Intrusions will ordinarily succeed only where the intruding citizens have more than usual aptitudes for the businesses they undertake. Those who desert their original social positions and occupations are at a disadvantage in the competition with those whose positions and occupations they assume; and they can overcome this disadvantage only by force of some superiority in respect of the occupations in which they compete. This leaving of men to have their careers determined by their efficiencies we may therefore call the principle of change in social organization.

As we saw that succession by inheritance conduces in a secondary way to stability, by keeping the places of authority in the hands of those who by age are made most averse to new practices, so here, conversely, we may see that succession by efficiency conduces in a secondary way to change. Both positively and negatively the possession of power by the young facilitates innovation. While the energies are overflowing, little fear is felt of those obstacles to improvement and evils it may bring, which, to those of flagging energies, look formidable; and at the same time the greater imaginativeness that goes along with higher vitality, joined with a smaller strength of habit, facilitates acceptance of fresh ideas and adoption of untried methods. Since, then, where the various social positions come to be respectively filled by those who are experimentally proved to be the fittest, the relatively young are permitted to exercise authority, it results that succession by efficiency furthers change in social organization, indirectly as well as directly.

Contrasting the two, we thus see that, while the acquirement of function by inheritance conduces to rigidity of structure, the acquirement of function by efficiency conduces to plasticity of structure. Succession by descent favors the maintenance of that which exists. Succession by fitness favors transformation, and makes possible something better.

As previously pointed out, "complication of structure accompanies increase of mass," in social organisms as in individual organisms. When small societies are compounded into a larger society, the controlling agencies needed in the several component societies must be subordinated to a central controlling agency: new structures are required. Recompounding necessitates a kindred further complexity in the governmental arrangements; and at each of such stages of increase all other arrangements must become more complicated. As Duruy remarks: "By becoming a world in place of a town, Rome could not conserve institutions established for a single city and a small territory. . . . How was it possible for sixty millions of provincials to enter the narrow and rigid circle of provincial institutions?" The like holds where, instead of extension of territory, there is only increase of population. The contrast between the simple administrative system which sufficed in old English times for a million people and the complex administrative system at present needed for many millions sufficiently indicates this general truth.

But now, mark a corollary. If, on the one hand, further growth implies more complex structure, on the other hand changeableness of structure is a condition to further growth; and, conversely, unchangeableness of structure is a concomitant of arrested growth. Like the correlative law just noted, this law is clearly seen in individual organisms. On the one hand, the transition from the small immature form to the large mature form, in a living creature, implies that not the whole only, but all the parts have to be changed in their sizes and connections; every detail of every organ has to be modified; and this implies the retention of plasticity. On the other hand, when, on approaching maturity, the structures are assuming their final arrangement, their increasing definiteness and firmness constitute an increasing impediment to growth: the unbuilding and rebuilding required before there can be the needful readjustment become more and more difficult. So is it with a society. Augmentation of its mass necessitates change of the preëxisting structures, either by incorporation of the increment with them, or by their extension through it. Every elaboration and further settlement of the structures presents an additional obstacle to this; and, when rigidity is reached, such modifications of them as increase of mass would involve are impossible, and increase is prevented.

Hence a significant relation between the structure of a society and

its growth. While each increment of growth is aided by an appropriate organization, yet this organization, being inappropriate to a greater mass, becomes thereafter an impediment to further growth. Whence it follows that organization in excess of need prevents the attainment of that larger size and accompanying higher organization which might else have arisen.

To aid our interpretations of the special facts presently to be dealt with, we must keep in mind the foregoing general facts. They may be summed up as follows:

Coöperation is made possible by society, and makes society possible. It presupposes associated men, and men remain associated because of the benefits association yields them.

But there can not be concerted actions without agencies by which actions are in some way adjusted in their times, amounts, and kinds; and the actions can not be of various kinds without the coöperators undertaking different duties. That is to say, the coöperators must fall into some kind of organization, either voluntarily or involuntarily.

The organization which coöperation implies is of two kinds, distinct in origin and nature. The one, arising directly from the pursuit of individual ends and indirectly conducing to social welfare, develops unconsciously and is non-coercive. The other, arising directly from the pursuit of social ends and indirectly conducing to individual welfare, develops consciously and is coercive.

While, by making coöperation possible, political organization achieves benefits, deductions from the benefits are entailed by such organization. Maintenance of it is costly; and the cost may become a greater evil than the evils escaped. It necessarily imposes restraints; and these restraints may become so extreme that anarchy, with all its miseries, is preferable.

Organization as it becomes established is an obstacle to reorganization. Both by the inertia of position, and by the cohesion gradually established among them, the units of the structures formed oppose change. Self-sustentation is the primary aim of each part as of the whole; and hence parts once formed tend to continue, whether they are or are not useful. Moreover, each addition to the regulative structures implying, other things equal, a simultaneous deduction from the remainder of the society which is regulated, it results that, while the obstacles to change are increased, the forces causing change are decreased.

Maintenance of a society's organization implies that the units forming its component structures shall severally be replaced as they die. Stability is favored if the vacancies they leave are filled without dispute by descendants; while change is favored if the vacancies are filled by those who are experimentally proved to be best fitted for them. Suc-

cession by inheritance is thus the principle of social rigidity; while succession by efficiency is the principle of social plasticity.

Though to make coöperation possible, and therefore to facilitate social growth, there must be organization, yet the organization formed impedes further growth; since further growth implies reorganization, which the existing organization resists.

So that while, at each stage, better immediate results may be achieved by completing organization, they must be at the expense of better ultimate results. These are to be achieved by carrying organization at each stage no further than is needful for the orderly carrying on of social actions.

SCIENCE AND CULTURE.*

By Professor T. H. HUXLEY, F. R. S.

SIX years ago, as some of my present hearers may remember, I had the privilege of addressing a large assemblage of the inhabitants of this city, who had gathered together to do honor to the memory of their famous townsman, Joseph Priestley; and, if any satisfaction attaches to posthumous glory, we may hope that the manes of the burned-out philosopher were then finally appeased. No man, however, who is endowed with a fair share of common sense and not more than a fair share of vanity, will identify either contemporary or posthumous fame with the highest good; and Priestley's life leaves no doubt that he, at any rate, set a much higher value upon the advancement of knowledge and the promotion of that freedom of thought which is at once the cause and the consequence of intellectual progress.

Hence I am disposed to think that, if Priestley could be among us to-day, the occasion of our meeting would afford him even greater pleasure than the proceedings which celebrated the centenary of his chief discovery. The kindly heart would be moved, the high sense of social duty would be satisfied, by the spectacle of well-earned wealth, neither squandered in tawdry luxury and vainglorious show, nor scattered with the careless charity which blesses neither him that gives nor him that takes, but expended in the execution of a well-considered plan for the aid of present and future generations of those who are willing to help themselves.

We shall all be of one mind thus far. But it is needful to share Priestley's keen interest in physical science; to have learned, as he had learned, the value of scientific training in fields of inquiry apparently far remote from physical science; to appreciate, as he would

* An address delivered on the occasion of the opening of Sir Josiah Mason's Science College, at Birmingham, England, on October 1, 1880.

have appreciated, the value of the noble gift which Sir Josiah Mason has bestowed upon the inhabitants of the Midland district. For us children of the nineteenth century, however, the establishment of a college under the conditions of Sir Josiah Mason's trust has a significance apart from any which it could have possessed a hundred years ago. It appears to be an indication that we are reaching the crisis of the battle, or rather of the long series of battles, which have been fought over education in a campaign which began long before Priestley's time, and will probably not be finished just yet.

In the last century, the combatants were the champions of ancient literature on the one side, and those of modern literature on the other; but, some thirty years ago, the contest became complicated by the appearance of a third army, ranged round the banner of Physical Science. I am not aware that any one has authority to speak in the name of this new host. For it must be admitted to be somewhat of a guerrilla force, composed largely of irregulars, each of whom fights pretty much for his own hand. But the impressions of a full private, who has seen a good deal of service in the ranks, respecting the present position of affairs and the conditions of a permanent peace, may not be devoid of interest; and I do not know that I could make a better use of the present opportunity than by laying them before you.

From the time that the first suggestion to introduce physical science into ordinary education was timidly whispered, until now, the advocates of scientific education have met with opposition of two kinds. On the one hand they have been pooh-poohed by the men of business who pride themselves on being the representatives of practicality, while on the other hand they have been excommunicated by the classical scholars, in their capacity of Levites in charge of the ark of culture and monopolists of liberal education. The practical men believed that the idol whom they worship—rule of thumb—has been the source of the past prosperity, and will suffice for the future welfare of the arts and manufactures. They were of opinion that science is speculative rubbish; that theory and practice have nothing to do with one another; and that the scientific habit of mind is an impediment rather than an aid in the conduct of ordinary affairs.

I have used the past tense in speaking of the practical men—for, although they were very formidable thirty years ago, I am not sure that the pure species has not been extirpated. In fact, so far as mere argument goes, they have been subjected to such a *feu d'enfer* that it is a miracle if they have escaped. But I have remarked that your typical practical man has an unexpected resemblance to one of Milton's angels. His spiritual wounds, such as are inflicted by logical weapons, may be as deep as a well and as wide as a church-door, but, beyond shedding a few drops of ichor, celestial or otherwise, he is no whit the worse. So, if any of these opponents be left, I will not waste time in vain repetition of the demonstrative evidence of the practical value of science;

but, knowing that a parable will sometimes penetrate where syllogisms fail to effect an entrance, I will offer a story for their consideration.

Once upon a time, a boy, with nothing to depend upon but his own vigorous nature, was thrown into the thick of the struggle for existence in the midst of a great manufacturing population. He seems to have had a hard fight, inasmuch as, by the time he was thirty years of age, his total disposable funds amounted to twenty pounds. Nevertheless, middle life found him giving proof of his comprehension of the practical problems he had been roughly called upon to solve, by a career of remarkable prosperity. Finally, having reached old age with its well-earned surroundings of "honor, troops of friends," the hero of my story bethought himself of those who were making a like start in life, and how he could stretch out a helping hand to them. After long and anxious reflection this successful practical man of business could devise nothing better than to provide them with the means of obtaining "sound, extensive, and practical scientific knowledge." And he devoted a large part of his wealth, and five years of incessant work, to this end. I need not point the moral of a tale which, as the solid and spacious fabric of the Scientific College assures us, is no fable, nor can anything which I could say intensify the force of this practical answer to practical objections.

We may take it for granted then, that, in the opinion of those best qualified to judge, the diffusion of thorough scientific education is an absolutely essential condition of industrial progress, and that the college opened to-day will confer an inestimable boon upon those whose livelihood is to be gained by the practice of the arts and manufactures of the district. The only question worth discussion is, whether the conditions, under which the work of the college is to be carried out, are such as to give it the best possible chance of achieving permanent success.

Sir Josiah Mason, without doubt most wisely, has left very large freedom of action to the trustees, to whom he proposes ultimately to commit the administration of the college, so that they may be able to adjust its arrangements in accordance with the changing conditions of the future. But, with respect to three points, he has laid most explicit injunctions upon both administrators and teachers. Party politics are forbidden to enter into the minds of either, so far as the work of the college is concerned; theology is as sternly banished from its precincts; and, finally, it is especially declared that the college shall make no provision for "mere literary instruction and education."

It does not concern me at present to dwell upon the first two injunctions any longer than may be needful to express my full conviction of their wisdom. But the third prohibition brings us face to face with those other opponents of scientific education who are by no means in the moribund condition of the practical man, but alive, alert, and formidable. It is not impossible that we shall hear this express

exclusion of "literary instruction and education" from a college which, nevertheless, professes to give a high and efficient education, sharply criticised. Certainly the time was that the Levites of culture would have sounded their trumpets against its walls as against an educational Jericho. How often have we not been told that the study of physical science is incompetent to confer culture; that it touches none of the higher problems of life; and, what is worse, that the continual devotion to scientific studies tends to generate a narrow and bigoted belief in the applicability of scientific methods to the search after truth of all kinds! How frequently one has reason to observe that no reply to a troublesome argument tells so well as calling its author a "mere scientific specialist"! And, as I am afraid it is not permissible to speak of this form of opposition to scientific education in the past tense, may we not expect to be told that this, not only omission, but prohibition of "mere literary instruction and education" is a patent example of scientific narrow-mindedness?

I am not acquainted with Sir Josiah Mason's reasons for the action which he has taken; but, if, as I apprehend is the case, he refers to the ordinary classical course of our schools and universities by the name of "mere literary instruction and education," I venture to offer sundry reasons of my own in support of that action. For I hold very strongly by two convictions: The first is, that neither the discipline nor the subject-matter of classical education is of such direct value to the student of physical science as to justify the expenditure of valuable time upon either; and the second is, that, for the purpose of attaining real culture, an exclusively scientific education is at least as effectual as an exclusively literary education. I need hardly point out to you that these opinions, especially the latter, are diametrically opposed to those of the great majority of educated Englishmen, influenced as they are by school and university traditions. In their belief culture is obtainable only by a liberal education, and a liberal education is synonymous not merely with education and instruction in literature, but in one particular form of literature, namely, that of Greek and Roman antiquity. They hold that the man who has learned Latin and Greek, however little, is educated; while he who is versed in other branches of knowledge, however deeply, is a more or less respectable specialist, not admissible into the cultured caste. The stamp of the educated man, the university degree, is not for him.

I am too well acquainted with the generous catholicity of spirit, the true sympathy with scientific thought, which pervades the writings of our chief apostle of culture to identify him with these opinions; and yet one may cull from one and another of those epistles to the Philistines, which so much delight all who do not answer to that name, sentences which lend them some support. Mr. Arnold tells us that the meaning of culture is "to know the best that has been thought and said in the world." It is the criticism of life contained

in literature. That criticism regards "Europe as being for intellectual and spiritual purposes one great confederation, bound to a joint action and working to a common result; and whose members have for their common outfit a knowledge of Greek, Roman, and Eastern antiquity, and of one another. Special local and temporary advantages being put out of account, that modern nation will in the intellectual and spiritual sphere make most progress which most thoroughly carries out this programme. And what is that but saying that we, too, all of us as individuals, the more thoroughly we carry it out shall make the more progress!"

We have here to deal with two distinct propositions: The first, that a criticism of life is the essence of culture; the second, that literature contains the materials which suffice for the construction of such a criticism. I think that we must all assent to the first proposition. For culture certainly means something quite different from learning or technical skill. It implies the possession of an ideal, and the habit of critically estimating the value of things by comparison with a theoretic standard. Perfect culture should supply a complete theory of life, based upon a clear knowledge alike of its possibilities and of its limitations. But we may agree to all this, and yet strongly dissent from the assumption that literature alone is competent to supply this knowledge. After having learned all that Greek, Roman, and Eastern antiquity have thought and said, and all that modern literatures have to tell us, it is not self-evident that we have laid a sufficiently broad and deep foundation for that criticism of life which constitutes culture. Indeed, to any one acquainted with the scope of physical science, it is not at all evident. Considering progress only in the "intellectual and spiritual sphere," I find myself wholly unable to admit that either nations or individuals will really advance if their common outfit draws nothing from the stores of physical science. I should say that an army without weapons of precision, and with no particular base of operations, might more hopefully enter upon a campaign on the Rhine than a man, devoid of a knowledge of what physical science has done in the last century, upon the criticism of life.

When a biologist meets with an anomaly, he instinctively turns to the study of development to clear it up. The *rationale* of contradictory opinions may with equal confidence be sought in history.

It is, happily, no new thing that Englishmen should employ their wealth in building and endowing institutions for educational purposes. But, five or six hundred years ago, deeds of foundation expressed or implied conditions as nearly as possible contrary to those which have been thought expedient by Sir Josiah Mason. That is to say, physical science was practically ignored, while a certain literary training was enjoined as a means to the acquirement of knowledge which was essentially theological. The reason of this singular contradiction between

the actions of men alike animated by a strong and disinterested desire to promote the welfare of their fellows is easily discovered. At that time, in fact, if any one desired knowledge beyond such as could be obtained by his own observation, or by common conversation, his first necessity was to learn the Latin language, inasmuch as all the higher knowledge of the Western world was contained in works written in that language. Hence Latin grammar, with logic and rhetoric, studied through Latin, were the fundamentals of education. With respect to the substance of the knowledge imparted through this channel, the Jewish and Christian Scriptures, as interpreted and supplemented by the Romish Church, were held to contain a complete and infallibly true body of information.

Theological dicta were, to the thinkers of those days, that which the axioms and definitions of Euclid are to the geometers of these. The business of the philosophers of the middle ages was to deduce, from the data furnished by the theologians, conclusions in accordance with ecclesiastical decrees. They were allowed the high privilege of showing, by logical process, how and why that which the Church said was true must be true. And, if their demonstrations fell short of or exceeded this limit, the Church was maternally ready to check their aberrations, if need be, by the help of the secular arm.

Between the two our ancestors were furnished with a compact and complete criticism of life. They were told how the world began and how it would end; they learned that all material existence was but a base and insignificant blot upon the fair face of the spiritual world, and that nature was, to all intents and purposes, the playground of the devil; they learned that the earth is the center of the visible universe, and that man is the cynosure of things terrestrial; and more especially was it inculcated that the course of nature had no fixed order, but that it could be and constantly was altered by the agency of innumerable spiritual beings, good and bad, according as they were moved by the deeds and prayers of men. The sum and substance of the whole doctrine was, to produce the conviction that the only thing really worth knowing in this world was how to secure that place in a better which, under certain conditions, the Church promised. Our ancestors had a living belief in this theory of life, and acted upon it in their dealings with education, as in all other matters. Culture meant saintliness—after the fashion of the saints of those days; the education that led to it was, of necessity, theological; and the way to theology lay through Latin.

That the study of nature—further than was requisite for the satisfaction of every-day wants—should have any bearing on human life was far from the thoughts of men thus trained. Indeed, as nature had been cursed for man's sake, it was an obvious conclusion that those who meddled with nature were likely to come into pretty close contact with Satan. And if any born scientific investigator followed his in-

stincts he might safely reckon upon earning the reputation, and probably upon suffering the fate of a sorcerer.

Had the Western world been left to itself in Chinese isolation, there is no saying how long this state of things might have endured. But, happily, it was not left to itself. Even earlier than the thirteenth century, the development of Moorish civilization in Spain and the great movement of the Crusades had introduced the leaven which, from that day to this, has never ceased to work. At first through the intermediation of Arabic translations, afterward by the study of the originals, the western nations of Europe became acquainted with the writings of the ancient philosophers and poets, and in time with the whole of the vast literature of antiquity.

Whatever there was of high intellectual aspiration or dominant capacity in Italy, France, Germany, and England, spent itself for centuries in taking possession of the rich inheritance left by the dead civilizations of Greece and Rome. Marvelously aided by the invention of printing, classical learning spread and flourished. Those who possessed it prided themselves on having attained the highest culture then within the reach of mankind.

And justly. For, saving Dante on his solitary pinnacle, there was no figure in modern literature, at the time of the Renascence, to compare with the men of antiquity; there was no art to compete with their sculpture; there was no physical science but that which Greece had created. Above all, there was no other example of perfect intellectual freedom—of the unhesitating acceptance of reason as the sole guide to truth and arbiter of conduct.

The new learning necessarily soon exerted a profound influence upon education. The language of the monks and schoolmen seemed little better than gibberish to scholars fresh from Virgil and Cicero, and the study of Latin was placed upon a new foundation. Moreover, Latin itself ceased to afford the sole key to knowledge. The student who sought the highest thought of antiquity found only a second-hand reflection of it in Roman literature, and turned his face to the full light of the Greeks. And after a battle, not altogether dissimilar to that which is at present being fought over the teaching of physical science, the study of Greek was recognized as an essential element of all higher education.

Thus the Humanists, as they were called, won the day; and the great reform which they effected was of incalculable service to mankind. But the Nemesis of all reformers is finality; and the reformers of education, like those of religion, fell into the profound but common error of mistaking the beginning for the end of the work of reformation. The representatives of the Humanists, in the nineteenth century, take their stand upon classical education as the sole avenue to culture, as firmly as if we were still in the age of Renascence. Yet surely the present intellectual relations of the modern and the ancient

worlds are profoundly different from those which obtained three centuries ago. Leaving aside the existence of a great and characteristically modern literature, of modern painting, and, especially of modern music, there is one feature of the present state of the civilized world which separates it more widely from the Renascence than the Renascence was separated from the middle ages. This distinctive character of our own times lies in the vast and constantly increasing part which is played by Natural Knowledge. Not only is our daily life shaped by it, not only does the prosperity of millions of men depend upon it, but our whole theory of life has long been influenced, consciously or unconsciously, by the general conceptions of the universe which have been forced upon us by physical science. In fact, the most elementary acquaintance with the results of scientific investigation shows us that they offer a broad and striking contradiction to the opinions so implicitly credited and taught in the middle ages.

The notions of the beginning and the end of the world entertained by our forefathers are no longer credible. It is very certain that the earth is not the chief body in the material universe, and that the world is not subordinated to man's use. It is even more certain that nature is the expression of a definite order with which nothing interferes, and that the chief business of mankind is to learn that order and govern themselves accordingly. Moreover, this scientific "criticism of life" presents itself to us with different credentials from any other. It appeals not to authority, nor to what anybody may have thought or said, but to nature. It admits that all our interpretations of natural fact are more or less imperfect and symbolic, and bids the learner seek for truth not among words but among things. It warns us that the assertion which outstrips evidence is not only a blunder but a crime.

The purely classical education advocated by the representatives of the Humanists in our day gives no inkling of all this. A man may be a better scholar than Erasmus, and know no more of the chief causes of the present intellectual fermentation than Erasmus did. Scholarly and pious persons, worthy of all respect, favor us with allocutions upon the sadness of the antagonism of Science to their mediæval way of thinking, which betray an ignorance of the first principles of scientific investigation, an incapacity for understanding what a man of science means by veracity, and an unconsciousness of the weight of established scientific truths, which is almost comical.

There is no great force in the *tu quoque* argument, or else the advocates of scientific education might fairly enough retort upon the modern Humanists that they may be learned specialists, but that they possess no such sound foundation for a criticism of life as deserves the name of culture. And, indeed, if we were disposed to be cruel we might urge that the Humanists have brought this reproach upon themselves, not because they are too full of the spirit of the ancient Greek, but because they lack it.

The period of the Renascence is commonly called that of the "Revival of Letters," as if the influences then brought to bear upon the mind of western Europe had been wholly exhausted in the field of literature. I think it is very commonly forgotten that the revival of science, effected by the same agency, although less conspicuous, was not less momentous. In fact, the few and scattered students of Nature of that day picked up the clew to her secrets exactly as it fell from the hands of the Greeks a thousand years before. The foundations of mathematics were so well laid by them that our children learn their geometry from a book written for the schools of Alexandria two thousand years ago. Modern astronomy is the natural continuation and development of the work of Hipparchus and of Ptolemy; modern physics of that of Democritus and Archimedes; it was long before modern biological science outgrew the knowledge bequeathed to us by Aristotle, Theophrastus, and Galen.

We can not know all the best thoughts and sayings of the Greeks unless we know what they thought about natural phenomena. We can not fully apprehend their criticism of life unless we understand the extent to which that criticism was affected by scientific conceptions. We falsely pretend to be the inheritors of their culture, unless we are penetrated, as the best minds among them were, with an unhesitating faith that the free employment of reason, in accordance with scientific method, is the sole guide to truth.

Thus I venture to think that the pretensions of our modern Humanists to the possession of the monopoly of culture and to the exclusive inheritance of the spirit of antiquity must be abated, if not abandoned. But I should be very sorry that anything I have said should be taken to imply a desire on my part to depreciate the value of classical education, as it might be and as it sometimes is. The native capacities of mankind vary no less than their opportunities; and, while culture is one, the road by which one man may best reach it is widely different from that which is most advantageous to another. Again, while scientific education is yet inchoate and tentative, classical education is thoroughly well organized upon the practical experience of generations of teachers. So that, given ample time for learning and destination for ordinary life, or for a literary career, I do not think that a young Englishman in search of culture can do better than follow the course usually marked out for him, supplementing its deficiencies by his own efforts.

But for those who mean to make science their serious occupation; or who intend to follow the profession of medicine; or who have to enter early upon the business of life—for all these, in my opinion, classical education is a mistake; and it is for that reason that I am glad to see "mere literary education and instruction" shut out from the curriculum of Sir Josiah Mason's College, seeing that its inclusion would probably lead to the introduction of the ordinary smattering of

Latin and Greek. Nevertheless, I am the last person to question the importance of genuine literary education, or to suppose that intellectual culture can be complete without it. An exclusively scientific training will bring about a mental twist as surely as an exclusive literary training. The value of the cargo does not compensate for a ship's being out of trim; and I should be very sorry to think that the Scientific College would turn out none but lop-sided men. There is no need, however that such a catastrophe should happen. Instruction in English, French, and German is provided, and thus the three greatest literatures of the modern world are made accessible to the student. French and German, and especially the latter language, are absolutely indispensable to those who desire full knowledge in any department of science. But, even supposing that the knowledge of these languages acquired is not more than sufficient for purely scientific purposes, every Englishman has, in his native tongue, an almost perfect instrument of literary expression; and, in his own literature, models of every kind of literary excellence. If an Englishman can not get literary culture out of his Bible, his Shakespeare, his Milton, neither, in my belief, will the profoundest study of Homer and Sophocles, Virgil and Horace, give it to him.

Thus, since the constitution of the college makes sufficient provision for literary as well as for scientific education, and since artistic instruction is also contemplated, it seems to me that a fairly complete culture is offered to all who are willing to take advantage of it.

But I am not sure but that at this point the "practical" man, scotched but not slain, may ask what all this talk about culture has to do with an institution whose object is defined to be "to promote the prosperity of the manufactures and the industry of the country." He may suggest that what is wanted for this end is not culture, nor even a purely scientific discipline, but simply a knowledge of applied science. I often wish that this phrase, "applied science," had never been invented. For it suggests that there is a sort of scientific knowledge of direct practical use, which can be studied apart from another sort of scientific knowledge, which is of no practical utility, and which is termed "pure science." But there is no more complete fallacy than this. What people call applied science is nothing but the application of pure science to particular classes of problems. It consists of deductions from those general principles, established by reasoning and observation, which constitute pure science. No one can safely make these deductions until he has a firm grasp of the principles; and he can obtain that grasp only by personal experience of the processes of observation and of reasoning on which they are founded.

Almost all the processes employed in the arts and manufactures fall within the range either of physics or of chemistry. In order to improve them, one must thoroughly understand them; and no one has a chance of really understanding them who has not obtained that

mastery of principles and that habit of dealing with facts which is given by long-continued and well-directed purely scientific training in the physical and the chemical laboratory. So that there really is no question as to the necessity of purely scientific discipline, even if the work of the college were limited by the narrowest interpretation of its stated aims. And, as to the desirableness of a wider culture than that yielded by science alone, it is to be recollected that the improvement of manufacturing processes is only one of the conditions which contribute to the prosperity of industry. Industry is a means and not an end; and mankind work only to get something which they want. What that something is depends partly on their innate, and partly on their acquired, desires. If the wealth resulting from prosperous industry is to be spent upon the gratification of unworthy desires, if the increasing perfection of manufacturing processes is to be accompanied by an increasing debasement of those who carry them on, I do not see the good of industry and prosperity.

Now, it is perfectly true that men's views of what is desirable depend upon their characters; and that the innate proclivities to which we give that name are not touched by any amount of instruction. But it does not follow that even mere intellectual education may not, to an indefinite extent, modify the practical manifestation of the character of men in their actions, by supplying them with motives unknown to the ignorant. A pleasure-loving character will have pleasure of some sort; but, if you give him the choice, he may prefer pleasures which do not degrade him to those which do. And this choice is offered to every man, who possesses in literary or artistic culture a never-failing source of pleasures, which are neither withered by age, nor staled by custom, nor embittered in the recollection by the pangs of self-reproach.

If the institution opened to-day fulfills the intention of its founder, the picked intelligences among all classes of the population of this district will pass through it. No child born in Birmingham, henceforward, if he have the capacity to profit by the opportunities offered to him first in the primary and other schools, and afterward in the Scientific College, need fail to obtain, not merely the instruction, but the culture most appropriate to the conditions of his life.

Within these walls, the future employer and the future artisan may sojourn together for a while, and carry through all their lives the stamp of the influences then brought to bear upon them. Hence, it is not beside the mark to remind you that the prosperity of industry depends not merely upon the improvement of manufacturing processes, not merely upon the ennobling of the individual character, but upon a third condition, namely, a clear understanding of the conditions of social life on the part of both the capitalist and the operative, and their agreement upon common principles of social action. They must learn that social phenomena are as much the expression of natural laws

as any others; that no social arrangements can be permanent unless they harmonize with the requirements of social statics and dynamics; and that, in the nature of things, there is an arbiter whose decisions execute themselves.

But this knowledge is only to be obtained by the application of the methods of investigation adopted in physical researches to the investigation of the phenomena of society. Hence, I confess, I should like to see one addition made to the excellent scheme of education propounded for the college, in the shape of provision for the teaching of sociology. For, though we are all agreed that party politics are to have no place in the instruction of the college, yet in this country, practically governed as it is now by universal suffrage, every man who does his duty must exercise political functions. And, if the evils which are inseparable from the good of political liberty are to be checked, if the perpetual oscillation of nations between anarchy and despotism is to be replaced by the steady march of self-restraining freedom, it will be because men will gradually bring themselves to deal with political as they now deal with scientific questions; to be as ashamed of undue haste and partisan prejudice in the one case as in the other; and to believe that the machinery of society is at least as delicate as that of a spinning-jenny, and not more likely to be improved by the meddling of those who have not taken the trouble to master the principles of its action.

In conclusion, I am sure that I make myself the mouth-piece of all present in offering to the venerable founder of the institution, which now commences its beneficent career, our congratulations on the completion of his work; and in expressing the conviction that the remotest posterity will point to it as a crucial instance of the wisdom which natural piety leads all men to ascribe to their ancestors.—*Nature.*

EXPERIMENTS WITH THE "JUMPERS" OF MAINE.*

By GEORGE M. BEARD, M. D.

ABOUT two years ago my attention was directed by my friend Mr. W. A. Croffut to the fact that, in the northern part of Maine, especially in the region of Moosehead Lake, there were to be found a class of people who presented most incredible nervous phenomena.

These people were called in the language of that region "Jumpers" or "Jumping Frenchmen." It was claimed that all, or most of them, were of French descent and of Canadian birth, and that their occupation was mainly that of lumbering in the Maine woods. Mr.

* Read before the American Neurological Association, June, 1880.

Croffut introduced me to D. W. Craig, Esq., a gentleman who had spent much time in that portion of Maine, and who had amused himself with watching and playing with these unfortunates.

In accordance with the request of Mr. Croffut and Mr. Craig, I began at that time an investigation of the subject through all accessible sources, and this year I visited Moosehead Lake in company with my friend Dr. Edward Steese, and made the investigations herein recorded.

I found two of the Jumpers employed about the hotel. With one of them, a young man twenty-seven years of age, I made the following experiments:

1. While sitting in a chair, with a knife in his hand, with which he was about to cut his tobacco, he was struck sharply on the shoulder, and told to "throw it." Almost as quick as the explosion of a pistol, he threw the knife, and it stuck in a beam opposite; at the same time he repeated the order "throw it" with a certain cry as of terror or alarm.

2. A moment after, while filling his pipe with tobacco, he was again slapped on the shoulder and told to "throw it." He threw the tobacco and the pipe on the grass, at least a rod away, with the same cry and the same suddenness and explosiveness of movement.

3. When standing near one of the employees of the house, he was told to "strike," and he struck him violently on the cheek. I took this person into the quiet of my own room, only my friend being with me, in order that the experiments might be made without interruption or disturbance. I sat down by him, explained to him the object of my visit, conversed with him in regard to his family history and his own personal experience and observation of his peculiarity, and every now and then, during the conversation, I struck him without warning on the shoulder or on the back, or mildly kicked him; and every time he was so struck he moved his shoulders upward slightly, sometimes moving both the shoulders and the arms, with or without the peculiar cry. He knew that I was studying his case; he knew that the kicks and strokes came from me, and yet he could not avoid making a slight jump or motion, as though startled.

4. While holding a tumbler in his hand, standing near to him, I told him to "throw it." He dashed the tumbler with great violence to the floor, and then began deliberately picking up the pieces in a very quiet and patient way. Whenever I struck him quietly, easily, and in such a way that he could see I was to strike him, he made only a slight jump or movement; but when the strike or kick was unexpected, though very mild in character, he could not restrain the jumping or jerking motion; but the cry did not always appear.

5. A handkerchief was suddenly thrown before his eyes by a person walking stealthily from behind. He jumped, just as though he had been struck.

Another case in the house, a lad sixteen years of age, was not so

bad as this other, but still presented all these phenomena: he jumped when he heard any sound from behind that was sharp and unexpected, and struck and threw when ordered to do so. The crowd around the hotel, partly for my benefit, kept him constantly teased and annoyed, so that when he approached he had a stealthy, suspicious, and timid look in his eye, as though he expected each moment to be jumped.

6. This man, while playing with one of his mates, had thrown him to the ground; some one approached near and commanded "Strike him," and he struck him very hard and explosively, with both hands at a time.

7. When standing by a window, he was suddenly commanded to "jump" by a person on the other side of the window. He jumped straight up, half a foot off the floor, with a loud cry, repeating the order which had been given to him.

8. When the two Jumpers were close together, they were commanded to "strike": each struck the other simultaneously—not mild or polite, but severe and painful blows. I took one of these men to my room and quietly conversed with him, and made the same experiments with him as with the other case. I found him much less irritable than the other, and he needed usually stronger excitation to produce the phenomena.

I experimented with him in the phenomenon of repeating language that was addressed to him. When the command was uttered in a quick, loud voice, he repeated the order as he heard it, at the same time that he executed it. When told to strike, he said "Strike" at the same time that he struck; when told to throw it, he said "Throw it" at the same time that he threw whatever was in his hand. It made no difference what language was used. I tried him with the first part of the first line of Homer's "Iliad," and with the first part of Virgil's "Æneid," languages, of course, of which he knew nothing, and he repeated quickly, almost violently, the sound as it was uttered—"Menin Aida," the first part of the first line of the "Iliad," and "Arma-vi," the first part of the first line of Virgil. In order to have it repeated, it was necessary that the command should be very short, as well as quickly and strongly uttered. He would not repeat a whole line, or even half a line, but simply a word or two. In these, as in the mind-reading experiments, I was able to establish my conclusions by exclusion—that is, by proving that only the involuntary action of mind on body could produce the phenomena.

These experiments were repeated again and again, under various conditions at different times, in such a way as to satisfy myself, absolutely, that the six elements of error that apply to all experiments with living human beings were all eliminated, and that the facts obtained were the solid residuum of an exact scientific investigation.*

* The six sources of error in experimenting with living human beings are—1. Unconscious deception on the part of the subject experimented on; 2. Intentional deception on

Many strange things are done by these Jumpers. One of those with whom I experimented came very near cutting his throat the day before I reached the lake. He was shaving, and the door slammed suddenly behind him; he jumped, and, had the razor been held in a different way, he might have inflicted a severe wound. One of these Jumpers being surprised by an order to "strike," while standing before a window, struck his fist right through the glass, cutting it severely. These Jumpers have been known to strike their fists against a red-hot stove; they have been known to jump into the fire, as well as into water; indeed, no painfulness or peril of position has any effect on them; they are as powerless as apoplectics or hysterics, if not more so; the absolute victims of the orders that are given them, or of the surprises that are played upon them; they must do as they are told, though it kill them, or though it kill others. I can find no evidence that the presence of water or of fire will interfere, even in the slightest degree, with the motions which they are compelled to make. As has been made apparent by the above description, it is not necessary that the surprises should come from any human being; it is not necessary that they should be ordered to strike or to jump; any sound, from any source, that comes upon them with sufficient severity and suddenness, for which they are not forewarned and forearmed, may cause them to jump and to cry. One of those on whom I experimented told me that the falling of a tree in the woods, when unexpected, would have the same effect upon him. He said that one time he was so alarmed by the sudden crash of a tree that he not only jumped, but was perfectly entranced, so that he could not move, although the tree did not fall upon him. The explosion of a gun or pistol is almost sure to excite these Jumpers. The screech of a steam-whistle is especially obnoxious to them, few of them, so far as I have been able to learn, having been able to withstand it. On one of the lake-steamers in which I returned from the hotel, there was a Jumper who, when the screech was heard, jumped right up, so that he nearly hit his head on the upper deck. As the steamer neared the landing and came to a place where he knew the whistle would sound again, he was warned to prepare himself, and he did so with such success, that on the first screech he jumped scarcely any; on the second, however, despite his care, he raised his shoulders perceptibly, but did not jump. In many of these cases, it may be observed, a simple raising of the shoulders, a sudden impulsive movement, is all that is done, there being no cry and no movement of the hands to throw or to strike.

the part of the subject experimented on; 3. Intentional collusion of other parties; 4. Unintentional collusion of other parties; 5. Chances and coincidences; 6. Phenomena of the involuntary life. In experimenting with the Jumpers the nature of the phenomena made it easy to eliminate the main element of error, intentional deception on the part of the subject—since, unless the subject is deceived or at least surprised, the phenomena do not appear.

Although called "Jumpers," they only *jump* in a minority of the experiments, the word jumping really including all such phenomena as lifting the shoulders, raising the hands, striking, throwing, crying, and tumbling. Jumpers have been known to fall head over heels over an embankment on which they were sitting, on suddenly hearing the whistle of a locomotive; they have been known to tumble head over heels over one another, when a number of them were sitting near each other.

The order to "drop it" they are compelled to obey, as well as that to strike or to jump or to throw. On one of the steamers on the Rangeley Lakes there was a waiter who was a Jumper, and when told to "drop it" he would drop whatever he had in his hands, even if it were a plate of baked beans, on the head of one of the guests. The Jumpers with whom I experimented exhibited the same phenomena.

These phenomena suggest epilepsy, particularly in their explosive character and in the nature of the cry. The hands strike or throw with a quick, impulsive movement, which is very hard to imitate artificially. They go off like a piece of machinery; it is more like the explosion of a gun than the movement of the limbs of even an angry man; and the cry suggests that which we hear in hysteria and in epilepsy. The face does not always exhibit any change, but in some cases there is a temporary flushing, and in others a temporary pallor.

All the Jumpers agree that it tires them to be very much jumped; that they feel worse after it, more or less exhausted and nervous; they all dislike to be jumped, and avoid it when it is possible; the more they are jumped the worse they are; and that after a while in the woods, where they are constantly teased and annoyed after the day's labor is over, they are made worse; whereas, after long periods of rest they become better, are less irritable and jump less, and do not jump so easily on excitement.

Nature of this Disease.—What, now, is the pathology of this jumping? How are we to rank these phenomena among the neuroses? What relation do they bear to the great family of diseases? Are they functional or structural? Are they physical or psychical? The answer is clear: jumping is a psychical or mental form of nervous disease, and is of a functional character. Its best analogue is psychical or mental hysteria, the so-called "servant-girl hysteria," as known to us in modern days, and as very widely known during the epidemics of the middle ages. Like mental or psychical hysteria, this jumping occurs not in the weak, or the nervous, or the anæmic, but in those, as a rule, in at least good if not firm and unusual health; there are no stronger men in the woods, or anywhere, than some of these Jumpers. Although some of them are injured by being excessively jumped for the time at least, yet to the majority, if not nearly all, this injury can not be said to be of a serious character. It does not apparently shorten life, and does not bring on, so far as I can learn, any other form of

nervous disease. It can not, therefore, be said to be in any sense a disease of nervous debility. Those who suffer most from it are the very opposite of neurasthenics or anæmics; they have none of the symptoms detailed in my work on nervous exhaustion; they are full-blooded and strong-nerved, capable of working hard and long at the most toilsome service, and will hold themselves up full and sturdy and enduring, side by side with the hardiest men in the nation. Like "servant-girl hysteria," and like certain forms of chorea or "jerks," as they are called, which appear or have appeared in certain religious revivals, like the "Holy Rollers"* as they were called in the religious revivals of northern New Hampshire, these Jumpers are contributions to psychology more than to pathology. Far out of the range of the aided senses, far beyond the reach of the microscope, or perhaps of the spectroscope, there may be molecular changes or disturbances which manifest themselves in these jumpings and strikings and throwings as a result and correlative. But for the present, possibly for all time, we can only study this subject psychologically; we can only approach it satisfactorily from the psychological side. Only those who clearly recognize the two distinct types of hysteria, the neurasthenic or anæmic form, which may be called *physical* hysteria, and the mental or psychical form, which may be called *psychical* hysteria, can understand the nature of this peculiar malady of the Jumpers; but those who do comprehend and recognize these two types of hysteria will have little difficulty in comprehending the general nature of this jumping and its position among the neuroses. Some of the cases of hysteria major on which Charcot has experimented with his metals and magnets belong, as I am persuaded from personal observation, to psychical or mental rather than to physical diseases. I can find in the families of those who suffer from jumping no proof of any form of functional or organic nervous disease.

Jumping is, therefore, a *trancoidal* condition, exhibiting a part of the phenomena of trance, and bearing the same relation to trance that certain epileptoidal conditions bear to epilepsy.

Although the phenomena exhibited by the Jumpers are analogous to those of mesmeric trance, of mental hysteria of the "Jerkers" and "Holy Rollers" in revivals, they yet differ from all these and all allied forms of nervous disorder in these two respects:

1. The *momentary* character of the manifestations.

In but a second or so all the acts of the Jumper—striking, throwing, dropping, crying, jerking, or jumping—are over completely, and he is about in the same condition as before he was surprised. The explosion of the Jumper, like the explosion of a revolver, is sudden and instantaneous; and like a revolver, also, the Jumper is at once ready for a new explosion on proper excitation. If we look at a Jumper five

* So called because they rolled over and over on the floor while under religious excitement.

seconds after he has been jumped, we see no sign or indication of what he has just done, or of what he can instantly be made to do.

On the other hand, the phenomena of trance, of mental hysteria, of the "Jerkers" or "Holy Rollers" may last in any given case from several minutes to several hours or days.*

Recent German investigations have, by an interesting coincidence, demonstrated that subjects in the mesmeric trance sometimes exhibit the phenomenon of repeating automatically what is said to them. Berger produces this effect by laying his warm hand on the neck of the mesmerized subject.

2. In the persistence and permanence of the liability to be excited.

After once the habit of jumping is formed, the subject, though varying in susceptibility at different times, is yet always capable of displaying the phenomena in a greater or less degree at any moment: once a Jumper, always a Jumper, expresses the prognosis. Epidemics of jerking and rolling are, on the contrary, limited in time and in their sphere, disappearing and dying utterly away with the excitements that give rise to them, and the habit of hysteria or of being entranced may also be outgrown.

Psychologically, these Jumpers, so far as I have been able to see or to learn, are modest, quiet, retiring, deficient in power of self-possession, conceit, and push, but no more so than many others in various races. I had been told that they were of a low order of organization—half-breeds, partly French, partly English; but in this respect I was misinformed: they are at least as intelligent and as capable of fulfilling the duties belonging to them as the average of their associates who are not Jumpers; some of them can read and write, and all whom I saw could converse in English with a reasonable degree of intelligence; possibly as much as we could expect of persons of their age and environment. But all of them, without exception, were of shrinking temperaments. In the chorea epidemics of the middle ages, or of the great religious revivals of this country, this class would be very likely to have been attacked.

Hereditary.—Before I visited Moosehead Lake, while I knew only those facts that were obtained at second or third hand, I felt quite sure that this disease would be likely to be a family inheritance. This deductive reasoning was confirmed by inductive observation. It is fully as hereditary as insanity, or epilepsy, or hay-fever, although it has no special relation to any of those forms of disease. In the family of one of those with whom I experimented there were five Jumpers, the father, two sons, and two grandchildren of the respective ages of four and seven years. In the family of another with whom I experimented there were four, all brothers. In the family of another

* In my work on "Trance" these phenomena are described in more detail than is here possible.

of whom I obtained information, but did not study, there were three cases, an uncle, a mother, and a brother. In another family there were two boys, both Jumpers. Here, then, were fourteen cases in four families. By the study of these cases, it was possible to trace the malady back at least half a century.

ENDEMIC AND CONTAGIOUS.—Jumping seems to be endemic, confined mainly to the north woods of Maine and to those of French descent, and is psycho-contagious—that is, can be caught by personal contact, like chorea and hysteria.

Shortly after I began these researches, I found in a copy of the London "Medical Record" brief reference to precisely similar phenomena on the other side of the globe, among the Malays. The notice was very brief, indeed, but it was sufficient to show that there was no difference in the phenomena as exhibited in these different races. I have been told that in northern Michigan these Jumpers are to be found, but have obtained no evidence on that point that is entirely satisfactory. It would not be improbable that this assertion should be proved to be true, since the class among whom Jumpers are found is somewhat migratory, although not so much so as the English and Americans.

ORIGIN AND PHILOSOPHY OF THE DISEASE.—Jumping is probably an evolution of *tickling*. Some, if not all, of the Jumpers, are ticklish —exceedingly so—and are easily irritated by touching them in sensitive parts of the body. It would appear that in the evenings, in the woods, after the day's toil, in lieu of most other sources of amusement, the lumbermen have teased each other, by tickling, and playing, and startling timid ones, until there has developed this jumping, which, by mental contagion, and by practice, and by inheritance, has ripened into the full stage of the malady as it appears at the present hour. This theory is in harmony with the general facts of physiology, and explains, better than any suggestion that has occurred to me, the history of what would otherwise appear to be without explanation, and almost outside of science. In a certain sense, we are all Jumpers; under sudden excitement, as of a blow, or a violent, unexpected sound, any person, even not very nervous, may jump and cry, somewhat as these Jumpers do, though not with all the manifestations of the Jumpers. Hysterical women, jumping and shrieking on slight excitement, we have all seen.

Everything about this subject is incredible. I do not expect that my readers will believe all, if they believe any, of what is here reported; rather they will find it easier to believe that I have been deceived; that the six sources of error that are involved in all experiments with human beings were not fully eliminated; that the Jumpers, in short, experimented with me, and not I with the Jumpers; and that, through all of this half century, the guides and physicians, the proprietors of hotels, and their neighbors, and relatives, and friends, have been the victims of intentional or unintentional fraud. But to

my own mind the most incredible fact of all is, not the existence of the phenomena, but that the phenomena have not been sooner observed by science, and that they have so long escaped the notice even of scientific men who live near or in those regions, and who frequently visit them.

Two of the best known citizens of Greenville—a town at the foot of Moosehead Lake—who have lived there very many years, if not all their lives, who have had these Jumpers in their employ, denied or doubted the existence of any of these phenomena, declaring that these so-called Jumpers were merely drunk or playing. My guide in the woods of northern New Hampshire, who had spent his whole life in those wilds, who was old enough to be a great-grandfather, denied, without reservation, the whole claim ; but, after investigating the subject with me, was compelled to admit its genuineness. One of my fishing companions in the woods, a clear-brained and vigorous man of business, and a man of the world, who for seventeen years had passed his summers in these regions, knew nothing of the subject until this season when I called his attention to it. All around these districts there are physicians, not in them but near them—for in the summer season the Jumpers scatter, to a certain degree, over the farms in the vicinity—and every year physicians and men of science, experts in various realms, visit for recreation the districts where these Jumpers most abound ; but if they see them they do not notice them, or if they notice them they do not understand them, or if they understand them they say nothing about them, and do not attempt to bring, or at least do not succeed in bringing, the phenomena into science.

THE AUGUST METEORS.*

By W. F. DENNING, F.R.A.S.

THE August shower of meteors forms one of the most attractive and important of the annual phenomena witnessed by astronomers, and the display is awaited every year with considerable interest, not only by a large section of habitual observers, but by many persons who have their attention called to it in a mere casual way by the frequency and brightness of the meteors. For, on the 10th of August, if the night is clear and the moonlight not very strong, a person can not be long in the open before his curiosity is excited by numbers of these "falling stars," which he will notice traveling swiftly athwart the sky, and leaving lines of phosphorescence along their paths. It is,

* For a description of the November meteor-showers, see "Popular Science Monthly," vol. xv, page 445.

however, not the business of the ordinary gazer to regard such occurrences with more than a passing interest, and he simply watches their progress with a feeling almost amounting to utter indifference. But it serves to while away a leisure hour and to give rise to some curious speculations as to the origin and end of the transient objects which now and again come before his view. The case is different with the scientific observer. He has a practical interest in the phenomenon, and zealously endeavors to record its more remarkable features as they become successively presented, and to watch with increasing diligence its further development in the later hours of the night, remembering that his notes must hereafter have some value in the general comparison of results.

Quetelet's catalogue of observed meteor-showers embraces a large number which obviously belong to the August period, but the majority occurred during the present century. This can not be ascribed to an increasing activity of the meteor-stream. It is at once explained by a greater assiduity of observation, and by the fact that the subject is

FIG. 1.—BROKEN STREAK OF A PERSEID IN PEGASUS, August 11th, 11h. 10m.

considered of more importance than formerly. Hence in more recent years the shower has been diligently looked for by many observers; and the result is that we find a large number of records of its displays. In former years it was comparatively neglected. The uncertainty attached to the whole subject rendered it unattractive, for there seemed little likelihood that it would ever become an important branch of astronomy, or yield any valuable results to the patient observer of its nightly displays. Thus we find, among historical records, only a few scattered references to this shower, and we are led, at first, to the inference that it was only rarely visible in consequence of the meteors being slightly dispersed over the orbit in former years. But the irregularities in the dates of its former apparitions may safely be ascribed to other causes than a physical peculiarity of the shower itself. The lack of interest in the subject would cause it frequently to be disregarded. Many of its exhibitions would pass wholly unobserved. Indeed, it would only be described when it recurred with such striking intensity as to force itself upon the attention as a celestial event of considerable interest. Between 811 and 841 it furnished a succession

of brilliant displays at the end of July. Then there occurred a break until eighty-three years later, when it several times reappeared with similar splendor. A wide interval of more than three hundred years brings us to the year 1243, when it seems to have been again recognized, after which, until 1709, there is only one other observation of the shower (in 1451). During the last hundred years it has, however, been frequently observed, though many of the recent displays can not be compared with those of ancient times. The intermittent and rare character of the shower, as it existed between the tenth and eighteenth centuries, proves that few returns were of a sufficiently imposing nature to be recorded, and that possibly the conditions were opposed to its appearance. If the meteors of the orbit during that period were condensed in the region of their derivative comet, then we can understand the singular paucity of observations. The earth, as it passed the node, would year after year encounter no meteors until the perihelion approach of the cluster, when possibly the display may have occurred in the daytime, and been of such brief duration as entirely to elude detection.

The entry of this stream into the solar system probably dates back to a very remote antiquity—for there are several circumstances which conspire to prove that such must have been the case, and that it preceded, by many ages, the apparition of the Leonids, Andromedes, and some of the other periodical meteor-showers. The fact that it constitutes an unbroken ring leads to the inference that it must have existed from the earliest times in order to bring about so complete a dispersion of its particles, for on its first introduction, as a comet, to the earth, it is to be assumed that it formed a condensed mass like the Leonids, and only appeared as a meteor-shower when the comet returned to perihelion. A very slight difference in the periodic times of the individual meteors following the nucleus must have eventually distributed them (by its cumulative effects) along the entire orbit. In other words, the original group must have undergone a process of lengthening out, until, at the present day, it consists of a parabolic zone of meteoric pellets, through which the earth passes annually on August 10th. Moreover, the radiant point of the shower often fails to become sharply defined. Several concentric streams of similar meteors appear to diverge from the region about *η Persei*, and their physical identity is unquestionable. They are merely the deflections or offshoots from the original system which must be greatly disturbed and contorted as the earth annually intersects it. The full effects of these perturbations can hardly be estimated : many of the particles must be diverted into new orbits, and one of the results upon the main stream may be a constant widening out, so that the apparent duration of the shower must go on increasing. It now actively extends over at least eight nights ; hence the width must exceed 10,000,000 miles. And some diminution in its intensity must occur at each return, unless there is a

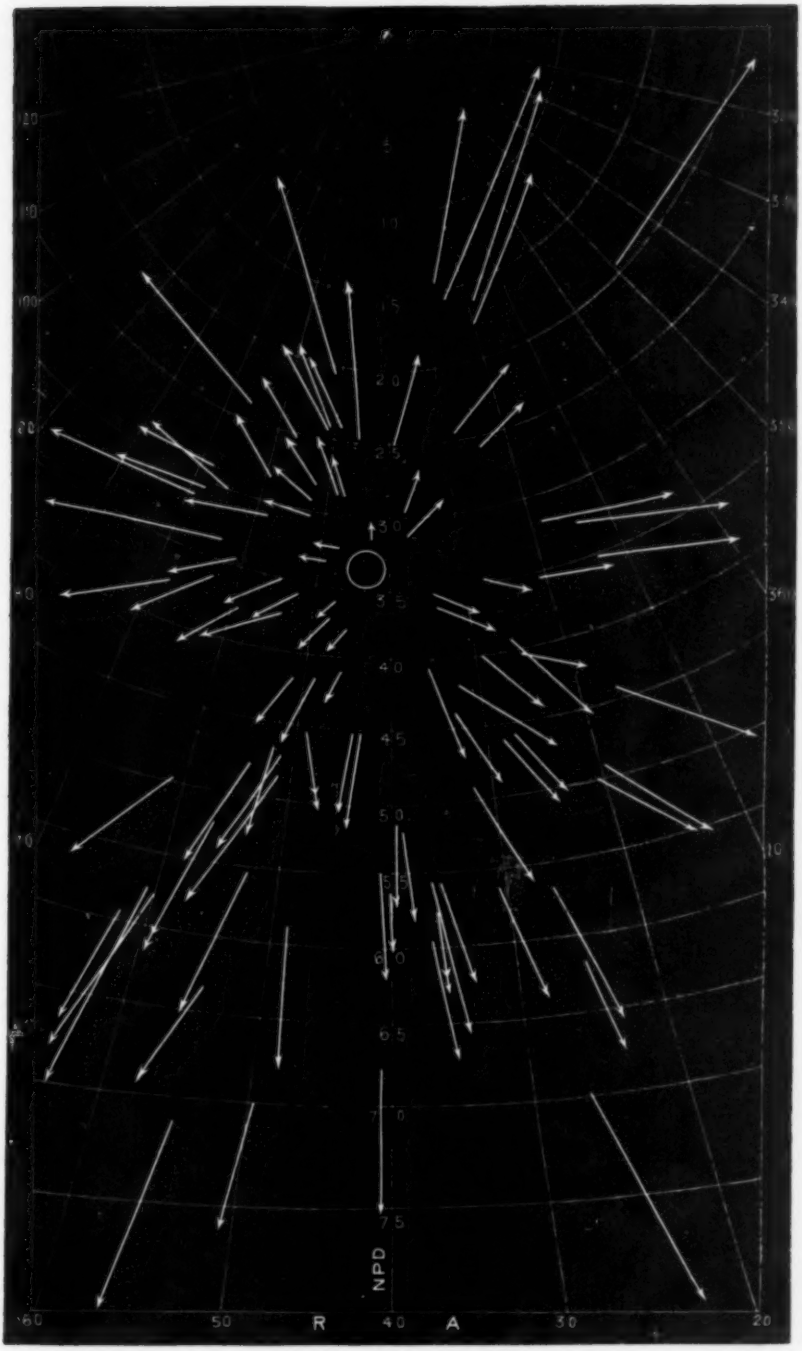


FIG. 2.—PERSEIDS NEAR THE RADIANT (44° + 57°), August 8th-12th.

source of compensation for the expenditure of its materials upon the earth. But, though many millions of the atoms are annually consumed in our atmosphere, the effect of the thinning out will be very gradual in making itself appreciable, for, as compared with the vast assemblage which constitutes the main ring, the proportion which encounters the earth is small indeed. As it is enveloped in the stream, comparatively few of the meteors are actually intercepted. By far the greater number pass by untouched. If a ball is thrown up in a thick shower of rain, it will only encounter a few drops. This may be taken as an illustration. The earth, with its diameter of 8,000 miles, can only meet with a few meteors in its rapid flight through a zone exceeding 10,000,000 miles in width.

The period of the August meteors is uncertain. Their distribution appears to have been so effectual that the element can not be determined. Some years give plentiful showers, but there have been no decided traces of regularly recurring maxima, as in the case of the Leonids. This may possibly be explained by the fact that the period is a long one, and would not become defined until after centuries of research. Comet III, 1862, which shows an exact resemblance of orbit to this system, was computed by Oppolzer to have a period of 121·5 years; and, as there occurred a fine display of the August meteors in 1863, we can not anticipate its periodical return until about 1964, if the calculations are reliable.

The August Perseids have been more frequently observed than any other system of shooting-stars, from the fact that they are visible every year with more or less distinctness, and that, as an annual shower, they can not be surpassed by any other display. The two celebrated streams of November 13th and 27th, occasionally giving rise to showers of great splendor, are periodical in character, though it is extremely probable that a few of their meteors encounter the earth at the regular return of the dates; notwithstanding that they may elude observation in consequence either of moonlight or cloudy weather, which, indeed, generally offers some impediment to success. But the August meteors recur annually with considerable intensity, and had attracted attention at a very remote epoch, though the phenomenon was not systematically studied until later times. It was reserved for Heis at Aix-la-Chapelle to more thoroughly investigate the meteors of August, for the previous observers, though they had ascertained the fact that the month was notable in this respect, had yet neglected to obtain any important data with regard to the number or directions of the meteors seen. Schmidt also, at Bonn, began assiduously to devote himself to this special line of inquiry. The particular night in August when the meteors were most plentifully distributed was found to be the 10th, though the numbers were subject to considerable variations in different years. Schmidt, from an average of several years of observations, gave the following as the horary number of falling stars

for one observer. His results are compared with a similar average derived by Major Tupman and the writer from observations in 1869–'71 and 1877–'80 respectively :

DATE.	FALLING STARS IN ONE HOUR.		
	Schmidt.	Tupman.	Denning.
6 August.....	6	36	13
7 "	11	37	23
8 "	15	45	26
9 "	29	..	44
(max.) 10 "	31	59	71
11 "	19	53	38
12 "	7	27	24

Schmidt's figures are very small and much below the numbers found in recent years. But the averages in the table are not thoroughly reliable, inasmuch as they are based upon only a few years' observations. A longer series might give a closer comparison, but it is seldom that the results of independent observers agree within small limits. There are differences in vision, modes of observation, and in position, which must obviously affect the numbers to no small degree ; and the intermittent character of the meteor-shower itself must give rise to discrepancies which can not at first sight be accounted for. The horary number of meteors on August 10th may vary, according to Heis, from 160 (in 1839) to 24 (in 1867). During the last ten years the writer has found little variation in the intensity of the annual returns when the conditions of weather and moonlight are fully taken into account ; and there is no question that some of the variations ascribed to the shower have no real existence, but are to be explained by the differences referred to above.

A fair comparison can not be instituted between the horary numbers found by observers, unless the observations, from which the values are deduced, are made, in each case, at similar hours of the night ; for shooting-stars, though often plentiful after midnight, are comparatively scarce in the evening hours. This is readily explained by the fact that the principal radiant points of the showers are massed together in the eastern region of the sky where the earth's orbital motion is directed, and it is obvious that in the evening hours, when the altitude of many of them is very low, and when others have scarcely appeared above the horizon, their operation is in a great measure restricted, so that only a feeble indication of their displays is perceptible at such a time. The case is entirely different at a later period of the night, when the constellations in which the several radiant points are situated have ascended high in the sky, and are in fact so placed that they may be seen to the greatest advantage. The August Perseids are always best observable in the morning hours, for the radiant point is very low on the

horizon soon after dark, and a person who persistently watches it during the night will find, with increasing elevation of the radiant, a corresponding increase in the hourly number of meteors. In 1877, at Bristol, the eastern sky was persistently watched between 9h. 30m. and 14h. 30m., when 354 meteors were seen; and, though the horary

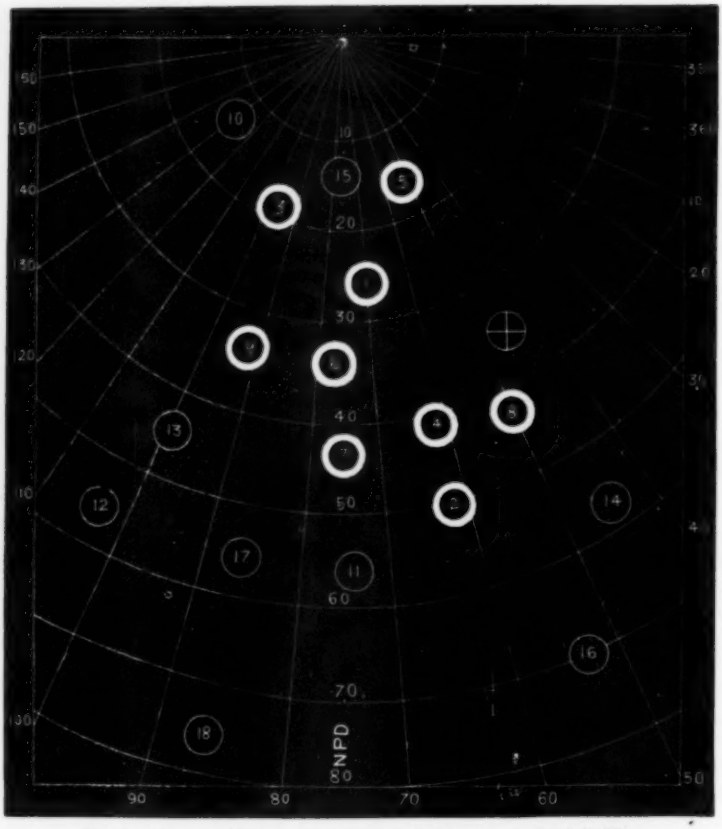


FIG. 3.—RADIANT POINTS EAST OF THE PERSEIDS, August 6th-12th.

Major Showers. Minor Showers. Perseids.

rate before 11h. was only 47, it rose to about 80 during the last half of the watch. Indeed, the number of meteors observed at the end of the watch was more than double the number recorded at the beginning of it. Thus it is apparent that the most favorable time for such observations is in the morning hours, and though it is generally inconvenient for amateurs to extend their vigils thus far, the importance of doing so can not be too strongly insisted on.

A typical feature of the Perseids is to be found in the streaks which frequently mark their course (Fig. 1), and serve an extremely useful purpose in enabling the directions to be registered with great accuracy. The theoretical velocity of these meteors is thirty-eight miles per second, so that they belong to the swiftest class of such bodies, and, as such, would be individually recorded with much difficulty, were it not for the special feature referred to. Their very rapid transient flights would baffle the observer as he stood endeavoring to retain the exact points of beginning and ending ; and in the majority of instances he must absolutely fail to get nearer than a mere approximation. Only in cases where the meteors sped from one star to another, or in courses parallel to closely adjoining stars, could the paths be truthfully reproduced on his map. But, fortunately for such investigations, we have no such difficulties to encounter. The phosphorescent line, almost invariably projected on the sky by the nucleus as it rushes along, remains to guide the eye in fixing its position. It is the authentic signature of the meteor gone before, and during the brief span of its endurance the observer knows how to utilize it. It is seldom these streaks last longer than three or four seconds, though in exceptional cases of Perseid fire-balls they have lingered several minutes. The writer found the average 1·8 second from many observations in August, 1880 ; and the most frequent duration is about two seconds. All the brighter meteors of the shower display them. Mr. Henry Corder, of Writtle, has observed these Perseids with great diligence in recent years, and retained many interesting notes of their peculiarities. Of 910 meteors belonging to this system, which he saw in the years 1871–'79, 526 were accompanied by streaks. These included 158 of the first magnitude, only 15 of which were devoid of streaks ; and 243 of the second magnitude, of which 72 were streakless. Among the smaller members the proportion was larger. He found the brightest meteors were generally pale-green, others orange, etc.

The luminous streaks, which are known to be the ordinary characteristic of these shooting-stars, have acquired a special significance from the fact that by their means the radiant point of the shower is capable of being ascertained with remarkable precision. This important element, to be reliably determined, must rest upon a large number of accurately recorded tracts, which intersect (on being prolonged backward) at a well-defined position. Many observers have succeeded in finding this from results of more or less value. Mr. R. P. Greg analyzed all the positions estimated prior to 1876, and gave the average at R. A. 44°, Dec. 56° north ; and Major Tupman, from a discussion of his own elaborate observations in the Mediterranean during the years 1869–'71, derived the point $45\frac{1}{2}° + 56°$, as the center of 28 sub-radiants. Evidently the two results, being founded on a large number of trustworthy records, and agreeing so closely as they did,

showed the true radiant to be situated on the northern limit of *Perseus*, close to the star *Eta* of that constellation ; and more recent determinations of a similar nature have fully corroborated that as the chief diverging center of the August meteors. Many other contemporary showers have been detected in the same region of the heavens, but the shower of Perseids recurs year after year from its accustomed point.

During the last eleven years the writer at Bristol has awaited the annual returns of this shower, and the aggregate results of observations during the interval between the 6th and 12th of August show that 2,345 meteors have been recorded, of which 1,428 belonged to the

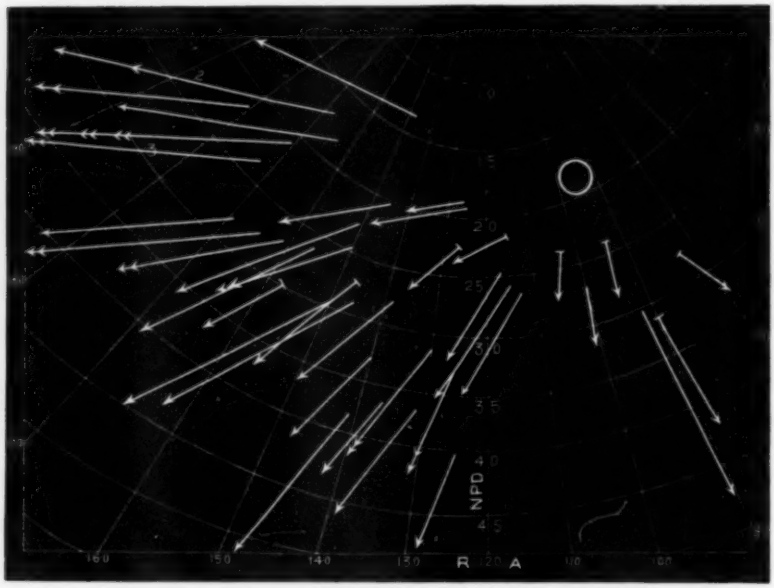


FIG. 4.—SHOWER FROM CAMELOPARDUS (96° + 71°), August 6th–12th.

display of Perseids, and 917 to other minor streams of the same epoch. In 1869 the radiant was judged to be at η *Persei ;* in 1871 at *B. Camelopardi ;* and in 1874 at 44° + 58½°. The average position found during the last five years has been at 44° + 57° ; and in the diagram (Fig. 2) a number of paths near this radiant are shown. Some of the meteors appear to be slightly erratic in their directions ; but this may be explained either by errors of observation or by a double or diffused radiant point, which must often occasion non-conformity in the observed flights. In 1878 two points of departure were manifest from a series of precisely fixed courses at 44° + 59° and 42½° + 54° ; but in 1879 the weather interrupted observations. The present year, however, afforded an exceptionally favorable opportunity to observers, and the major radiant determined by the writer was at 44° + 56°, with the decided traces of a sub-radiant at 45° + 60°. In 1878 Major Tupman

found the shower double at 46° + 57·6° and 38° + 56°; and in 1880 he strongly corroborated the results obtained at Bristol, though his observations were mainly confined to the night of August 9th. At the latter station the radiant apparently advanced among the stars of *Perseus*, for, while early in the month it was observed at 38° + 56°, it had shifted to 49½° + 57½° by the 13th. The same peculiarity was noted in 1877, when the following determinations were made:

	Radiant.		Radiant.
August 3d–7th	40° + 56°	August 12th	50° + 55°
August 10th	43 + 58	August 16th	60 + 59

There is a prominent display of meteors from the star-group χ *Persei* at the end of July and beginning of August, and it is possible that these showers may belong to the same system of concentric meteor-streams. It is certain that this fact of a progressive radiant requires fuller elucidation, and to this end observers should keep the data obtained each night separate. It may also be suggested that the radiant point should be ascertained during each hour of observation, and then, when the series are compared, any displacement must immediately become obvious, and its extent and character well defined by the observations. The meteors from *Perseus* are so numerous, and the place of divergence so readily denoted by their enduring streaks, that there will be no difficulty in an investigation of this kind. The last two years' observations have shown how exactly the radiant may be found by carefully conducted researches, and how closely the positions derived by different observers will agree on being compared together:

OBSERVER.	1879, August. Chief Radiant.	1880, August. Chief Radiant.
G. L. Tupman	45° + 56°	44° + 56°
H. Corder	45 + 57	45 + 58
E. F. Sawyer	44½ + 57	44½ + 56½
W. F. Denning	46 + 58	44 + 56

From these values a mean of 44·8° + 56·8° is derived, which is probably very near the truth. There is a secondary shower higher in declination (at about 44½° + 60°), but this is merely a branch of the same stream, for the meteors exhibit the same specialties of appearance as those common to the major shower. An apparent diffuseness of the radiant point is often brought about by imperfectly registered tracks, and by allotting the meteors of bordering showers to the radiant of the Perseids, when in fact they belong to evidently distinct families.

A few years ago the writer undertook the investigation of these co-Perseid showers from the large mass of shooting-stars which had been registered at this epoch at foreign observatories, and are contained

in the published catalogues of Heis, Schiaparelli (1872), Weiss, and Konkoly. These include many thousands of paths observed during the period from August 6th to 12th, and such of these as were obviously directed from radiant points situated eastward of *Perseus* were projected on the star-maps prepared by Professor Herschel for the purposes of the Luminous Meteor Committee of the British Association. In all 762 meteors were thus utilized, and they gave distinct evidence of the positions of a number of active streams in *Auriga* and *Camelopardus*, some of which were previously observed by Heis, and many of them have been confirmed by the writer during the last five years. The following list embraces the chief radiants thus deduced:

Meteor-Showers east of Perseus, August 6th–12th.

No.	Radiant. α	δ	No. of Meteors.	No.	Radiant. α	δ	No. of Meteors.
1	70°	+ 64°	74	10	134°	+ 77°	30
2	61	+ 39	59	11	74	+ 33	28
3	96	+ 71	87	12	104	+ 34	13
4	61	+ 48	59	13	99	+ 46	17
5	51	+ 74	62	14	45	+ 33	18
6	78	+ 56	59	15	76	+ 74	20
7	76	+ 45	43	16	52	+ 20	14
8	50	+ 47	42	17	87	+ 34	14
9	92	+ 57	42	18	87	+ 15	8

The relative positions of these showers are depicted in the diagram (Fig. 3), where the more prominent displays of the group are represented by deeper circles than the minor. Some of the latter can not yet be regarded as certainly established, inasmuch as they rest on slender materials.

Heis devoted much attention to the meteors of the August period during more than forty years (1833–'75), and in his extensive "results," published in 1877, gives the following as the chief radiant points for August 9th–11th:

Symbol.	Radiant. α	δ	No. of Meteors.	Symbol.	Radiant. α	δ	No. of Meteors.
A_{11}	45°	+ 52°	233	Cr_{11}	273°	+ 56°	93
B_4	330	+ 55	164	St_{12}	40	+ 45	118
B_5	292	+ 70	135	St_{15}	56	+ 70	105
Cr_3	12	+ 32	93	St_{17}	27	+ 21	70
Cr_6	355	+ 81	103	St_{18}	25	+ 58	282
Cr_8	11	+ 60	192	St_{19}	295	+ 44	110
Cr_9	73	+ 63	125	St_{20}	51	+ 75	133

But, in addition to these, there are a large number of radiants scattered over the sky, especially in the eastern quadrant. One of the most notable of these proceeds from the eastern extremity of *Aries* (44° + 25°), and supplies some bright meteors in the morning hours; but the most conspicuous shower discovered east of *Perseus* at this epoch lies in *Camelopardus*, and in the diagram (Fig. 4) a number of its meteors, falling among the stars of *Ursa Major*, are reproduced

from the catalogues of foreign observers. This shower, however, escaped the detection of Heis and others, who had been engaged in similar investigations, though it appears to be of more importance than several radiants in its vicinity which have been independently determined by several observers. At the end of July, 1878, the writer noted a few brilliant, slow meteors, from a point at 96° + 72°, and this may have been an early evidence of the radiant which is placed in a region bare of large trees between *Telescopium* and *Polaris*. It is just north of the triangle of faint stars (*l. p. q. Camelopardi* of Bode), east of a line drawn from *β Aurigæ* to *Polaris*, and will, no doubt, be frequently reobserved in future years, though the shower of Perseids usually monopolizes attention at the epoch of its annual returns.

There is a shower near *η Persei* (No. 2), well defined, on August 6th–12th, August 21st–23d, and September 6th–15th. At the latter

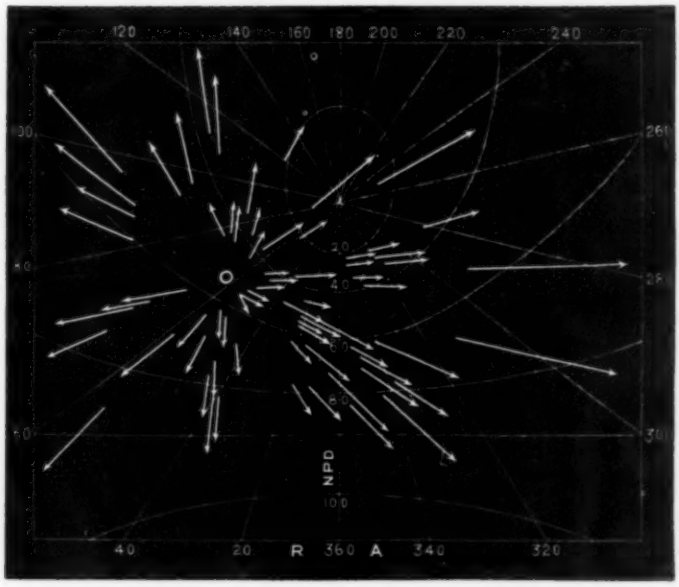


FIG. 5.—SHOWER OF PERSEIDS (61° + 36°), MAX. September 6th, 7th.

epoch it furnishes some fine meteors and constitutes a prominent display. The diagram (Fig. 5) gives the positions of eighty-six paths conforming to this radiant, observed at Bristol, and at several foreign stations in September.

The ordinary designation of Perseids for the special meteor-shower of August 10th is always understood in its individual application, though it must not be supposed that this is the only shower of Perseids visible in that month. The fact is, there are many separate showers directed from that constellation early and late in August, so that we require

some distinguishing titles or symbols to conveniently particularize either of them which it may be necessary to refer to. The method now adopted, of naming the chief periodical showers by the constellations in which their radiant points are situated, is very appropriate; and such displays as the Orionids, Leonids, and Geminids, have become so well known by their titles that it would be unwise and inconsistent to attempt reform. But with regard to the minor systems, which are becoming very numerous, and require an equally ready mode of expression, there is a great difficulty in avoiding complications.

There are certainly five nearly simultaneous showers of Perseids early in August; and in every month of the year, except May and June, meteors continue to fall from that constellation. If the present mode is adopted of styling them Perseids I, Perseids II, and so on progressively, a good deal of confusion must eventually arise as new systems are discovered; and this classification by Roman numbers, however appropriate it may be in some of its other applications, will have to give way to a more distinguishing means of reference. The name at present only gives indication of the constellation from which the meteors emanate, without regard to the date or approximate place of the radiant, and it seems to me that the difficulty may be obviated by including the nearest fixed star and the epoch with that name. To render the proposal clear, let us take the different streams proceeding from the under-mentioned points in *Perseus* in August: 44°+56°, 32°+53°, 61°+36°, 61°+48°, 46°+47°, which may be thus termed:

η Perseids (August 10th).
χ Perseids (August 1st–3d).
ε Perseids (August).
μ Perseids (August).
α Perseids (August).

This is apparently a preferable method to that of Perseids I, II, III, IV, and V, which must occasion endless trouble in references to find what special stream is meant. Moreover, the numbers seem only in fair application when affixed progressively to the successive showers of the year, for it would be hardly consistent to call a radiant visible in *Perseus* early in January by the designation of, say, "Perseids XXXVIII." Yet this is what we are drifting to, unless a fresh system is introduced to accommodate the rapidly increasing number of meteor-streams.—*Popular Science Review.*

THE EARLY PRACTICE OF MEDICINE BY WOMEN.*

By Professor H. CARRINGTON BOLTON, Ph. D.,
of Trinity College, Hartford, Connecticut.

IN attempting to sketch the history of the entrance of women into the medical profession, we find the earlier periods obscured by a meagerness of material and a lack of sequence which our superficial researches have failed to supplement.

Isolated cases of gifted women attaining notable surgical skill and successfully pursuing the divine art of healing are recorded at various epochs in the history of the intellectual development of woman, but they occur at long intervals of time and in widely scattered chronicles. In the following pages we have not undertaken to present an exhaustive history or catalogue of female practitioners of medicine ; we have simply collected a few scattered notices, and molded them into an outline to be hereafter filled up by a more competent hand.

These notices refer to the earlier history only, and by earlier history we mean the period prior to the establishment of medical schools for women, and to the present movement for their higher education. From the earliest times women have successfully grappled with a most difficult branch of medical science, gynecology, but long-existing and deep-seated prejudices prevented an extension of their practice, and save in exceptional cases they were forbidden both the acquirement of accurate and systematic knowledge and the exercise of their chosen vocation. So long as the practice of medicine formed a part of the priestly functions, as in ancient Egypt, the crafty guardians of superstition sedulously concealed their superior knowledge from an ignorant and credulous people, and especially from women. Yet the story of the birth of Moses shows that female gynecologists were not unknown to the Egyptians.

At a later period the Greeks thought to add dignity to the practice of medicine by forbidding it to slaves and (forsooth !) to women. During the middle ages, when every branch of science was more or less dishonored by degrading superstitions, we find women, as well as men, yielding to their influence and exercising the double calling of sorceress and healer of the sick ; nor has the intelligence of the common people even in the nineteenth century reached such a height as to render the business of medical clairvoyant nugatory and profitless.

The invention of medicine was almost universally attributed by the ancients to the gods, and it is a curious fact that in both Egyptian and Grecian mythology we find female deities occupying important

* An address delivered at the commencement exercises of the Woman's Medical College of the New York Infirmary, May 27, 1880.

relations to the healing art. To the Egyptian deity Isis, the wife and sister of Osiris, peculiar medical skill was attributed, and a multitude of diseases were regarded as the effects of her anger. According to tradition she had given unequivocal proof of her power by the restoration of her son Orus to life. She was the reputed discoverer also of several remedies, and even as late as Galen the materia medica contained several compounds which bore her name: thus, in the symbolical language of the Egyptian priestly physicians, the vervain was called the "tears of Isis."

According to the annals of Grecian mythology, Hygeia, daughter of Æsculapius, the god of medicine, was worshiped in the temples of Argos as the goddess of health. In art, Hygeia is represented as a virgin wearing an expression of benevolence and kindness, and holding in one hand a serpent which is feeding from a cup in the other. She was regarded as the goddess both of physical and mental health, thereby personifying the aphorism, "Mens sana in corpore sano." The Greeks also ascribed medical power to Juno, who, under the name of Lucina, was held to preside over the birth of children, and to Ocyroe, daughter of the Centaur Cheiron, who was renowned for his skill in surgery and medicine. The sorceresses Medea and Circe were said to make use of herbs in their enchantments and for the purpose of counteracting the effects of poisons. These and similar fables probably preserve in allegoric form facts connected with the practice of medicine by women in the remotest antiquity. The writings of Homer have been examined to ascertain his testimony, but, with the exception of slight reference to woman's part in nursing wounded warriors, he contributes nothing to the subject under consideration.

The learned among the Celts, the Druids, were at the same time judges, legislators, priests, and physicians. By persuading the people that they maintained intimate relations with the gods, they succeeded in imposing their authority on the ignorant masses. "Their wives, who were called *Alraunes*, exercised the calling of sorceresses, causing considerable evil by their witchcraft, but caring for warriors wounded in battle. They gathered those plants to which they attributed magic virtues and they unraveled dreams" (Dunglison).

The first female practitioner who received a medical education appears to be Agnodice, a young Athenian woman who lived about 300 B. C. To satisfy her desire for knowledge she disguised herself in male attire, and, braving the fatal results of detection, dared to attend the schools of medicine forbidden to her sex. Among her instructors was numbered Herophilus, the greatest anatomist of antiquity and the first who dissected human subjects. After completing her studies, Agnodice preserved her disguise and practiced her chosen calling in the Grecian capital with great success, giving particular attention to the diseases of her own sex. The physicians of Athens becoming jealous of Agnodice's great reputation and lucrative practice, summoned

her before the Areopagus, and accused her of abusing her trusts in dealing with female patients. To establish her innocence, Agnodice disclosed her sex, and her persecutors then accused her of violating the law prohibiting women and slaves from studying medicine, but the wives of the most influential Athenians arose in her defense and eventually obtained a revocation of the law.

The laws and customs of the Romans, as well as of the Greeks, were antagonistic to the entrance of women into the medical profession, yet Galen, Pliny, and others have preserved the names of a few distinguished in the art of healing: Phænarete, the mother of Socrates, Olympia of Thebes, Salpe, Sotira, Elephantis, Favilla, Aspasia, and Cleopatra. Of these, details are generally wanting. Scribonius Largus writes of an "honest matron" who cured several epileptic patients by an absurd remedy, and mentions having purchased of a woman a prescription for the cure of colic, the composition of which she had learned in Africa. Why Aspasia appears in this connection is not perfectly clear; the talented wife of Pericles, renowned as "a model of female loveliness," was doubtless too involved in affairs of state to undertake the absorbing cares of the medical profession. Cleopatra, the accomplished and luxurious Queen of Egypt, of whom so many marvels are related, is named among those women possessed of medical skill; she is reported to have compounded cosmetics and to have written on the art of preserving beauty, but this statement is probably no more worthy of credence than that of the infatuated alchemists of the middle ages, who would persuade us that Cleopatra was the fortunate possessor of the philosopher's stone and of the universal solvent. In proof of the former statement, they point to her personal attractions, unchanged by increasing years, and to her immense wealth; in proof of the latter, they rely with confidence on the well-known fable of the solution of the costly pearl at the extravagant banquet to Marc Antony.

In a Roman lady named Fabiola we find an early predecessor of Florence Nightingale. She was of the illustrious house of Fabius, and was celebrated in the fourth century for piety and charity. She is to be held in grateful remembrance as the founder of hospitals in Italy, and she is said to have personally nursed the sick at Ostia. The establishment of hospitals is commonly credited to the Emperor Julian, 362 A. D., with whom Fabiola was contemporary; perhaps she took an active part in the humane movement, and held a position analogous to that of lady manager in modern times.*

Half a century later lived a woman justly distinguished for combining in one person a high degree of female loveliness, womanly virtue, and intellectual strength: though not occupied with the art of

* Celsus, who wrote in the reign of Augustus (A. D. 1), mentions large hospitals where patients were treated with specific medicines. (Milligan's Ed., p. 14.) Seneca also refers to them as "valetudinaria."

healing, we can not pass in silence the accomplished Hypatia. Born at Alexandria in the latter part of the fourth century, the daughter of Theon, an eminent mathematician and philosopher, she soon excelled her father in these branches of learning. After profiting by profound studies under celebrated masters at Athens and Alexandria, she publicly taught philosophy at both these centers of culture. Gibbon writes of her, "In the bloom of beauty and in the maturity of wisdom, the modest maid refused her lovers and instructed her disciples." On Hypatia's inhuman murder at the instigation of the jealous Cyril and his fanatical followers, it is not here necessary to dwell.

The practice of medicine by women obtained to some extent during the middle ages. Under the influence of Mohammedan rule, women were placed in excessive isolation, and it is not surprising to find under these circumstances that certain women were skilled in attending to the requirements of their own sex. Thus Albucasis, of Cordova, one of the most skillful surgeons of the twelfth century, secured the services of properly instructed women for assistance in operations on females in which considerations of delicacy intervened. Avicenna also, writing of remedies for diseases of the eyes, mentions a collyrium compounded by a woman well versed in medical science. On the whole, however, the number of women instructed in medicine among the Arabs was very small, owing possibly to the inferiority to which women were condemned by Eastern usages.

In Christian countries the nuns as well as the priests attended to the healing of the sick as an act of charity and piety. Abélard, in the twelfth century, permitted the practice of surgery to those of the convent of the Paraclete, over which Héloïse presided. The most celebrated of the learned nuns was Hildegarde (A. D. 1098–1180), abbess of the convent of Rupertsberg, near Bingen on the Rhine. She compiled a sort of materia medica, which comprises a variety of superstitious remedies. Radegonde of France, the founder of a convent at Poitiers (died 587), the pious ascetic Elizabeth of Hungary (died 1231), Hedwigia, wife of Henry the Bearded, and other women who devoted themselves to the care of the sick, may be properly regarded as praiseworthy exemplars of Christian benevolence rather than educated practitioners of medicine.

In the famous school of medicine established at Salernum by Benedictine monks in the eleventh century, we find women taking an important part. Ordericus Vitalis, in his "Ecclesiastical History" (written about 1130), relates that an abbot eminent in natural sciences, and especially distinguished in medicine, visited Salernum in the year 1059 for the purpose of discussing medical topics, and found no one erudite enough to reply to his propositions save a certain woman of great learning. This woman he does not name, but she is supposed to be the same as Trotula of Ruggiero, whose reputation at that period was world-wide. At Salernum, women were engaged in the preparation of

drugs and cosmetics, and in the practice of medicine among persons of both sexes: such were Abella, author of two medical poems; Costanza Calenda, the talented and beautiful daughter of a skillful physician, under whose instructions she attained to a doctor's degree; Mercuriade, author of several treatises; Rebecca Guarna, Adelmota Maltraversa, and Marguerite of Naples, who obtained royal authority for practicing the medical art. (Beaugrand, in "Dict. Encyc. Sci. Médicales.")

The ancient and honorable universities of Italy were, we believe, the first to recognize the capacity of women to give instruction of a high character. The University of Bologna, founded in 1116, was attended in the year 1250 by ten thousand students, engaged in the study of jurisprudence, of philosophy, and of medicine. "Here was first taught the anatomy of the human frame, the mysteries of galvanic electricity, and later the circulation of the blood." Here, too, were the earliest successful experiments in admitting women to occupy professorial chairs, for a long line of female professors taught in many departments of learning.*

As early as the thirteenth century two women were numbered among the eminent professors of the University of Bologna, Accorsa Accorso and Bettisia Gozzadini, the former held the chair of Philosophy, the latter that of Jurisprudence. In the fourteenth century the lovely and learned Novella d'Andrea, daughter of a distinguished lawyer, often took her father's place in the professorial chair, and instructed his students in law. Of Novella it is reported that she was so beautiful that she lectured behind a curtain, "lest, if her charms were seen, the students should let their young eyes wander over her exquisite features and quite forget their jurisprudence." The rival University of Padua, founded in 1228, had also its female representatives. Of these the most distinguished was Elena Lucrezia Cornaro. This interesting woman was born at Venice, June 5, 1646, and at a very early age exhibited an extraordinary capacity for acquiring languages. She was familiar with French, Spanish, Latin, Greek, and Hebrew, besides her native Italian, and had some acquaintance with Arabic. While endowed by nature with poetical and musical talents, she possessed at the same time great perseverance and capacity for serious studies, and discoursed eloquently on abstruse topics in philosophy, mathematics, astronomy, and theology. At the age of thirty-two, the University of Padua conferred upon her the degree of Doctor of Philosophy. Cornaro seems never to have held any public position, being naturally of a retiring disposition, and moreover exceedingly devoted to the order of St. Benedict. After acquiring a European reputation, she died at the comparatively early age of thirty-eight (1684).

The beginning of the following century witnessed the birth of one

* According to Madame Villari, whose papers on the "Learned Women of Bologna" furnish us with many of the succeeding data, there is to the present day no law preventing women from graduating at Italian universities or taking professorial positions.

of the most gifted women the world has ever seen. Laura Caterina Bassi was born at Bologna, October 31, 1711. She was the daughter of a distinguished lawyer and *littérateur*, and at a tender age manifested extraordinary precocity, being able while still a child to translate fluently most difficult Latin and Greek. Encouraged by her father, she pursued her studies under the guidance of eminent masters; she learned physiology and medicine with the erudite physician Gaetano Tacconi, mathematics with Manfredi, and natural philosophy with the disciples of Gassendi, and she astonished these profound philosophers by her talents. Laura Bassi studied for the pure love of knowledge, and had no ambition to seek public honors, but, to gratify the pardonable pride of a father as well as the earnest desires of her instructors, she consented to support a philosophical thesis before a learned audience of professors. This event took place on the 17th of April, 1732, before she had reached the age of twenty-one years. The occasion was made one of festivity by the whole city, who turned out to do her honor; the assemblage was presided over by two cardinals, Lambertini, afterward Pope Benedict XIV, and Grimaldi.

According to custom her thesis was opposed by seven learned men; to these she replied in elegant Latin with great success and amid the applause of the distinguished audience. A month later the degree of Doctor was conferred upon her, and she was honored by a position in the Faculty of Philosophy. The Senate subsequently bestowed upon her the chair of Physics, and commemorated the event by striking a medal which bore her own portrait. She held the professorship twenty-eight years with marked success, paying particular attention to mathematics and physics, also to *belles-lettres*. Several académies of learning elected her to membership. In 1738 she was married to J. J. Veratti, a physician, and became in the course of time the mother of twelve children. A learned French *littérateur* who visited Bologna in her day thus describes her appearance: "Laura Bassi has a countenance slightly marked with small-pox, but of a sweet and modest expression; her black eyes are sparkling, yet tranquil, and she is serious and composed in demeanor without affectation or vanity. Her memory is tenacious, her judgment sound, and her imagination active." She died in the year 1778, at the age of sixty-seven.

Laura Bassi does not seem to have pursued medical studies, and certainly never engaged in practice; but any account of the gifted women of Bologna who labored in this direction would be incomplete without a brief notice of Madame Veratti.

Contemporary with this interesting woman lived another, less gifted but scarcely less renowned. Anna Morandi was born at Bologna five years later than Laura Bassi, and died four years earlier. She became the wife of Giovanni Manzolini, a poor, hard-working maker of anatomical models. Manzolini was an expert painter and modeler in wax, and was employed by one Lelli to construct a series of anatomical

models for the use of the professors in the Institute of Bologna. Anna not only aided her husband, but soon surpassed him in skill, and particularly in that scientific knowledge upon which the success of their joint labors so largely depended. About this time Giovanni Antonio Galli, a skillful surgeon and Professor of Gynecology, opened a school of obstetrics in his house, and, encouraged by him, Anna began to lecture on anatomy to private classes. In these lectures she not only imparted with peculiar talent the knowledge derived from her husband, but she also communicated many discoveries made by herself. So great was her skill in all dissections requiring delicacy of touch and minuteness of detail, and so clearly did she demonstrate both theoretically and practically the wonderful structure of the human body, that she rapidly acquired a European reputation, and her lecture-room was frequented by students of all countries.

In 1755 Anna Manzolini became a widow, and was left with very slender means of support, but her good qualities raised up friends who secured for her a comfortable subsistence. Though she received tempting offers from other Italian universities, and even from England and Russia, she preferred to remain in her native city, Bologna. Not long after her husband's death she was appointed to the chair of Anatomy in the Bologna Institute.

Anna Morandi-Manzolini enjoys the distinction of having been the first "to reproduce in wax such minute portions of the human body as the capillary vessels and the nerves." Her collection of anatomical models, still to be seen at the Institute of Science, bears silent testimony to her remarkable skill and accurate knowledge. "Her lectures were delivered in the fragrant cedar hall which is one of the modern sights of Bologna and in which Lelli's anatomical wooden figures supporting the canopy over the professorial chair attract general admiration." In the anatomical gallery of the university is to be seen her portrait in wax, modeled by herself at the request of many admiring friends. Anna Manzolini closed a laborious and honored life in 1774, at the age of fifty-eight years.

The city of Bologna, in the middle of the eighteenth century, saw three gifted women simultaneously occupying seats in the faculty of its ancient university. Besides Laura Bassi and Anna Morandi-Manzolini, of whom we have briefly spoken, Maria Gaetano Agnesi was equally distinguished.

Maria Agnesi was born at Milan, March 16, 1718. At an early age she manifested a remarkable facility for acquiring languages, and when only twenty years old was able to discourse in French, Spanish, German, Greek, and Hebrew, besides her mother-tongue. She displayed marked ability also in philosophy and mathematics, and while still young sustained one hundred and ninety-one theses which were afterward printed under the title "Propositiones Philosophicæ." In 1748 Agnesi published a treatise on algebra, including the differential and

integral calculus, in which she displayed wonderful judgment and erudition. This work ("Instituzioni Analitichi") was afterward translated by Colson, the Lucasian Professor of Mathematics at Cambridge, and was used by the students of that university. In 1750 her father, who was Professor of Mathematics at the University of Bologna, fell sick, and she obtained permission of the good Pope Benedictus XIV to occupy her father's chair. In person Agnesi is said to have been beautiful, modest, and of pleasing manners. Her severe studies overtaxed her delicate frame, and shortly after she renounced the world and took refuge among the Blue Nuns at Bologna. In this nunnery she lived several years a devotee and an invalid; she died in 1799.

While Laura Bassi taught physics, Anna Morandi-Manzolini anatomy, and Maria Agnesi mathematics, in the Bolognese University, we might naturally expect the gentler sex to avail themselves of the opportunity of studying under their sisters' instructions. And such, in fact, was the case: the names of some of these students are recorded by the historian, many of whom received the degrees of Doctor of Philosophy and Doctor of Medicine. In 1799 Doctor Maria delle Donne appears as Professor of Medicine and Obstetrics; Clotilda Tambroni was Professor of the Greek Language and Literature, from 1793 to 1808. To these names should be added those of Novella Calderini, Maddalena Buonsignori, Dorotea Bocchi (who was both doctor and professor), Christina Roccati, Ph. D., Zaffira Ferretti, M. D., Maria Sega, M. D., and numerous graduates of Padua, Pavia, Ferrara, and other Italian universities.

Leaving the Italian Peninsula, which was so productive of remarkable personages, we will briefly examine the position of women practitioners of medicine in other parts of Europe.

Beaugrand states that the most ancient document extant relative to the organization of surgery in France forbids the practice of surgeons and of *female* surgeons who have failed to pass a satisfactory examination before the proper authorities. This paper bears the date 1311. References to female surgeons appear again in an edict of King John in 1352; from these documents it appears that women exercised the function of surgeon under legal authority. At a somewhat later period we find the calling of physician followed by women in Spain, Germany, and England.

In Spain, the Universities of Cordova, Salamanca, and Alcala honored many women with doctors' degrees. We note also the appearance at Madrid in 1587 of a learned medical work entitled "Nueva filosofia de la naturaleza del hombre," and published over the name Olivia del Sabuco. Of this person, however, nothing whatever is certainly known, and it has been conjectured that the name Olivia was a pseudonym assumed by some eminent physician.

In Germany many women cultivated medical science: Barbara Weintrauben was an author of no great merit; the Duchess Eleanor of

Troppau, Catharina Tissheim, Helena Aldegunde, and Frau Erxleben are deserving passing notice. The last mentioned was one of the most successful female practitioners of the last century. Her maiden name was Dorothea Leporin, but she is best known as Frau Erxleben. Fräulein Leporin pursued her medical studies at the University of Halle, and obtained a diploma in 1734. She settled in the little town of Quedlinburg, at the foot of the Hartz Mountains, became the wife of the rector of the Church of St. Nicholas in the same place, industriously practiced her profession, and became eminent for her skill and learning. Her son, J. C. P. Erxleben, inherited from his mother a love of scientific pursuits and became a distinguished naturalist and professor in the University of Göttingen.

In England, Anna Wolley and Elizabeth of Kent were occupied with the preparation of drugs as early as the seventeenth century, and both published works on medical subjects.

In this hasty and superficial sketch of the history of the early practice of medicine by women we would not be true to the facts if we omitted mention of certain ignorant and vulgar women who assumed medical knowledge and medical skill to impose upon a too credulous public. That avaricious women, fond of notoriety and careless of their reputation, should imitate the methods adopted in every age by unprincipled men, is not surprising, though it may be mortifying. To this class belonged Louise Bourgeois, nurse to Marie de' Medici, the Queen of Henry IV of France; though an ignorant charlatan, she acquired extraordinary influence over her royal patroness, and her career abounds in curious, eventful episodes. She was the author of several medical treatises on the diseases of women, one of which was published at Paris in 1617.

A century later another female practitioner flourished, of whom women have no reason to be proud. In the year 1738 Mrs. Joanna Stephens proclaimed in London that she had discovered a sovereign remedy for a painful disease. Notwithstanding her gross ignorance and vulgar demeanor, she secured a large circle of patients from among the upper and wealthy classes, and, after enriching herself by enormous fees drawn from their credulity, she proposed to make her medical discovery public in consideration of the modest sum of twenty-five thousand dollars. A subscription was started for this purpose and enthusiastically taken up; the clergy, lords, and ladies, with an inexplicable infatuation, hastened to add their names to the list of subscribers. Failing, however, to raise so large a sum of money, Mrs. Stephens's friends obtained a grant of the desired amount from Parliament. The certificate testifying to the "Utility, Efficacy, and Dissolving Power of the Medicines," bears the date March 5, 1739, and is signed by twenty justices. These dearly purchased remedies were three in number, "a Powder, a Decoction, and Pills." The powder consisted of calcined egg-shells and snails; the decoction was a dis-

gusting mixture of herbs, soap, and honey, boiled in water; and the pills were made of "calcined wild-carrot seeds, burdock-seeds, ashen keys, hips, and haws—all burned to a blackness—soap and honey."

Contemporary with Mrs. Stephens lived another impostor, Mrs. Mapp, sometimes known as "Crazy Sally of Epsom," and described as an "enormously fat, ugly creature, accustomed to frequent country fairs, about which she loved to reel, screaming, abusive, and in a state of beastly intoxication." This attractive lady was by profession a bone-setter, and was patronized by patients of rank and wealth, who sought her charily bestowed favors with ill-disguised contempt of her person. The town authorities of Epsom greatly esteemed Mrs. Mapp, or, perhaps we should say, highly valued the benefit the town derived from the influx of wealthy patients, and they offered her the sum of five hundred dollars per annum if she would continue to reside in the town.

The first half of this century has witnessed the career of a few women eminent in the art of healing; in France Madame La Chapelle had an extensive gynecological practice, and Madame Boivin attained to such distinction that she was honored with the degree of Doctor of Medicine by the University of Marburg. In Germany Charlotte Heidenreich and Frau Heiland, her step-mother, were similarly honored with doctors' diplomas.

It is the glory of America that she is distinguished above all countries not only as the cradle of liberty but also as the foster-mother of the intellectual advancement of women. Yet this has not always been the case; in the early chronicles of the colonists (themselves refugees from persecution) we find, strangely enough, many laws of an exacting and repressive character, some of which were aimed directly at the ambition and zeal of women. In the famous Blue Laws of Connecticut the following curious entry occurs under the date of March, 1638: "Jane Hawkins, the wife of Richard Hawkins, had liberty till the beginning of the third month called May, and the magistrates (if shee did not depart before) to dispose of her; and in the mean time shee is not to meddle in surgery or phisick, drinks, plaisters or oyles, nor to question matters of religion except with the Elders for satisfaction." ("True Blue Laws of Connecticut," by J. H. Trumbull, 1876.)

A hundred and forty years later we find marked progress in liberality in the State of Connecticut. As early as 1773, in the town of Torrington, Litchfield County, two women were greatly honored and much sought for on account of their remarkable skill as accoucheuses. The first of these, Mrs. Jacob Johnson, to quote the historian of Torrington (Rev. Samuel Orcutt), was as thoroughly known and trusted in her profession as any physician that was ever in the town. "She rode on horseback, keeping a horse for the special purpose, and traveling night and day, far and near," to meet her engagements. "She kept an account of the number of cases she had, and the success

of the patients, and the new-comers, and of these last there is at least one living in the town. In the midst of her usefulness she was removed by death, and it became a great inquiry, 'Who will take the place of Granny Johnson?'" This question was answered in the person of Mrs. Huldah Beach, daughter of Aaron Loomis, Jr., more successfully than was anticipated. Mrs. Beach became as celebrated in her calling as Granny Johnson, and continued to attend to her professional duties until an advanced age. She was a woman of remarkably fine personal appearance and decided dignity of carriage, yet marked kindliness of manner. Her intellectual strength and ability were perceptible to every one, and she in consequence commanded great respect in all classes of society, and won the confidence of the people so that but few calls were made on any other physician in her specialty, on the western side of the town. She also rode as far as Winchester, Goshen, and Litchfield.

Dr. Orcutt, whose "History of Torrington" has furnished us with these particulars, remarks in this connection, "Many have imagined that, in the practice of medicine by women, a new era has arrived, but in this there is only a 'restoration of the lost arts.'"

Our allotted task is completed, yet we can not close this address without a brief survey of the present period, in which the facilities afforded women in all branches of learning contrast strongly with the formerly wellnigh insurmountable impediments and obstacles.

Women desirous of acquiring medical knowledge are no longer obliged to disguise themselves in male attire like Agnodice the Athenian, nor are practitioners liable to suffer the penalties of the law for their works of benevolence and charity. In 1880 the young woman with aspirations for intellectual culture finds open to her such excellent training-schools as Holyoke, Wells, and Rutgers, such noble institutions as Vassar, Smith, and Wellesley. Does she not shrink from contact with her brothers, she may gain entrance into many universities, either expressly founded in a liberal spirit, as Oberlin, Cornell, and Ann Arbor, or which have yielded to the steady pressure of public opinion, and now open their doors more or less widely to the gentler sex. To enumerate the latter would be tedious and unprofitable; suffice it to say that even venerable and aristocratic Harvard has lately joined the number, and our own Columbia, should her President's views prevail, will not be slow to follow.

The young woman who seeks intellectual training of a more technical character, with a view to adopting a professional career, will find many avenues opening up with constantly increasing privileges and facilities. The student in art, thanks to the philanthropy of our venerable citizen, Peter Cooper, can, without incurring expense, acquire a knowledge of designing or of wood-engraving which will hardly fail to secure for her a competence. The student in biology will receive her share of attention at a summer school of science on our Atlantic

seaboard, or held in connection with some enterprising institution of learning. The student in pharmacy and chemistry can conduct her researches on an equality with men, or, if she prefer, in laboratories controlled and officered in large part by women themselves.

The student in medicine now gains access to medical colleges in nearly every State in the Union, and the legitimacy of her pursuit as well as her ability to grapple with it gains increasing advocates. "She is no longer regarded as too good and too stupid to study medicine." The candidate for medical honors also finds in Boston, Philadelphia, New York, and Chicago, well-appointed schools of medicine especially adapted to her needs, with corps of trained and sympathizing instructors ready to lend a helping hand.

Looking across the Atlantic, we find countries so lately intolerant of the intellectual advancement of woman at last yielding, not always gracefully, to the inevitable. The little republic of Switzerland and the mighty empire of Russia have for many years manifested practical sympathy with the cause; and now, slowly yet surely, conservative England begins to recognize the fact that the Anglo-Saxon race, with its boasted love of liberty, has been neglectful of its duty to womankind.

To trace any more fully the history of the recent period does not fall within the province of our address; we look to the pioneers of this movement who are still with us for an exhaustive and authentic record such as participators and eye-witnesses alone can supply.

METHODS IN INDUSTRIAL EDUCATION.*

By Professor SILVANUS P. THOMPSON.

SHALL we have a school in the workshop, or a workshop in the school? Or what other combination can we devise that will permit mental and scientific training to proceed after the age has been attained at which serious manual labor must begin? Hitherto we have been contented at most to organize night schools, evening classes, and so-called Mechanics' Institutes for our apprentices, leaving it to their own caprice whether they chose to employ their leisure hours in self-improvement or squander them in self-indulgence. On the Continent of Europe somewhat different ideas have prevailed. In Belgium, Switzerland, Germany, France, and even Russia, there are innumerable examples of Technical Schools and Polytechnic Schools of all descriptions, which profess to teach with greater or less completeness the

* Continuation of article from the September "Contemporary Review," entitled "The Apprenticeship of the Future," the first part of which was published in the November Monthly, under the title of "Education as a Hindrance to Manual Occupations."

elements of certain handicraft industries. Overlooking the extreme diversity of type that exists among such schools, we have been apt mentally to throw them all together, and to refer to the supposed system on which they proceed as "the Continental system," in contradistinction to our British system of training, as we are pleased to term our obsolescent institution of apprenticeship proper. Nothing could be more misleading than this classification. It arises from lack of information as to the nature and work of such schools. It is not surprising, when such ignorance prevails, that the fallacy has in consequence been widely spread that the long undisputed superiority of British-made goods was due to the superiority of the British system. On the contrary, that superiority, which arose out of quite other economic causes, was the very thing which stirred up the Germans, Swiss, Belgians, and French to devise schemes for training workmen more efficiently and intelligently than was done in England, since only by such means could they hope to compete with her industries. Let the significant fact, that a very large proportion of the foremen of workshops in our skilled industries are Germans or Belgians, attest the result of a higher technical training. Besides the innumerable *Gewerb-schulen* and *Real-schulen* of Germany, where a general preparatory scientific and technical education is given, that empire can now produce a long array of trade-schools, sometimes organized as polytechnic schools, and sometimes devoted to particular trades, such as weaving, dyeing, or carpentry. In Switzerland such schools also abound; and in the commercial centers of Belgium they exhibit an extensive and healthy development. In France there are the technical schools of Douai, Chalons, and Aix, the École la Martinière of Lyons, the Horological School of Besançon, the Apprenticeship School of Havre, where workers in wood and iron are trained, and twenty others, including five or six in or near Paris. The technical schools of Paris present, indeed, so much diversity in their several organizations and results that it would be extremely difficult, even by going over a much wider area, to find so many different yet thoroughly characteristic types. To understand how completely different are the systems of organization by which it has been sought to solve this great problem, it would be necessary to pass from the Polytechnicum of Zurich—the Technical *University, par excellence*—to the Horological School of Besançon, and from the *Kunst-gewerbschulen* of Munich and Nuremberg to the unrivaled Pedagogic School of Moscow, and even then the list of types would be less complete than that which is afforded by the schools of Paris. In that great capital, in addition to the École des Arts et Métiers, the École des Mines, and the École Centrale des Arts et Manufactures, whose portals open only to an older and better educated class of students, and the great schools of modern type, such as the École Turgot, the Collége Chaptal, and the École Commerciale in the Avénue Trudaine, which qualify their pupils for commercial and mercantile careers,

there are a group of technical schools intended for those whose primary education is not yet, or only just completed, and in which not only theoretical technical instruction is given, but where systematic instruction in some useful handicraft forms a necessary feature. From among these diverse types we select four, for each one of which its promoters claim that its practical success solves the knotty problem of the day. These four schools are the *École Communale*, in the Rue Tournefort; the *Institution de Saint Nicolas*, in the Rue de Vaugirard; the *École Professionelle*, established by MM. Chaix et Cie. in their printing establishment in the Rue Bergère; and the *École Municipale d'Apprentis*, in the Boulevard de la Villette.

The first two of these may be said to exemplify, though with striking diversity of method, *l'atelier dans l'école*, the workshop in the school; the third is an excellent instance of the school in the workshop; while the fourth belongs strictly to neither type.

The *École Communale*, situated in the Rue Tournefort, a crooked back slum behind the Panthéon, is the most recent of the group which we have selected. Founded in November, 1873, at the instance of M. Salicis, and with the coöperation of M. Gréard, the energetic Director of Primary Education for the Department of the Seine, it is intended rather to prepare for than to supplant apprenticeships of a more rigorous type. The pupils of this school are not apprenticed at all in the ordinary sense; there is no contract, and they earn nothing. Most of them are very young—even as young as eight or nine years—nor have they yet completed their elementary education. If they stay out the prescribed three years' course, they not only get as good a schooling as in any of the ordinary elementary schools, but they will also have seen something of constructive industry. During the first two years they are sent to work *for a day at a time*, in rotation, in one or other of the occupations of the workshop. An "apprentice" will thus have one day in the carpenter's shop at the bench or the lathe; the next he will be learning how to forge a bolt; the next he will devote to metal-turning—all his exercises being directed by practical workmen in charge of the shops. During the third year he will settle down to some one pursuit. The hours of actual labor are short, for the chief part of the day is devoted to lessons, only an hour and a half each morning and afternoon being given to manual labor. All learn drawing and modeling. Every pupil works from drawings which he has previously made to scale: no matter what he does, whether he is making a mortice-joint, rabbeting a window-frame, or filing down an iron nut, it is always done according to a careful sketch made beforehand. No articles whatever are made for sale; indeed, all commercial elements are scrupulously avoided, and the objects given as exercises are hardly such as would serve a useful purpose: little joints of wood accurately squared; little cones or cylinders turned with perfect truth of line. Here and there a more valuable article, a model of a crane in metal, or a model

system of beveled gearing-wheels; but nothing more marketable. The genial director, M. Laubier, enters heartily into the work of his pupils. He has himself designed and executed many of their exercises—the plaster casts, the geometrical models, and the ingenious scholastic appliances of the institution. He thinks his school to be the type of the elementary school of the future. He has need to be an enthusiast, to train successfully his fifty apprentices and his two hundred non-working children on a grant not exceeding sixteen hundred dollars a year, salaries, tools, and materials included. He upholds the rotation system, believing extreme division of labor to be at this stage prejudicial to the development of the youthful faculties. He does not want to sell the produce of his workshops, as the construction of objects which would be made to sell would not afford so good a training for his boys. He admits that they do not work so rapidly as apprentices who have been brought up amid the hourly exigencies of trade; but he adds that he prefers cultivating their intelligence to quickening mere manual dexterity; that will come later. And what are the results? "Our apprentices," says the director, "being at once fit for useful work on entering the factory, are less often employed to run errands; they are better treated, steadier. I could tell you of young lads of fifteen who are actually earning two francs and a half, and two francs seventy-five centimes a day, and who in six months more will be paid as regular workmen."

The *Institution de Saint Nicolas*, in the Rue de Vaugirard, is the oldest of the schools, having been founded in 1827. It is under the exclusive management of a religious guild known as the *Frères des Écoles Chrétiennes*, who devote themselves entirely to education. In this truly remarkable establishment there are eight hundred and ninety boys, all children of artisans, all boarders. Of this number, about two hundred are apprentices who come here to learn their trade. None are admitted who can not already read and write. The greater part of the day is given up to manual work, only two hours being reserved for schooling on three days of the week, on the alternate three days the two hours are devoted to drawing. On entering the premises the visitor is first introduced into a sort of little museum, in which are exhibited articles made by the pupils of the establishment—a truly surprising collection to have been executed by little fellows from eleven to fifteen or sixteen years of age. Here there are picture-frames, bronzes, panels carved in oak, wood-engravings that would not discredit either the "Graphic" or the "Illustrated"; farther on, in another handsome case, are telescopes, leveling instruments, a model engine, a saxhorn, and a trombone; and, in yet another, some exquisitely neat engraved maps, some of them executed on commission for the Government, together with the medals they won in Paris, Vienna, and Philadelphia. A varied assortment it would seem, and indeed the system under which such works are produced is without a parallel

in this country. There are in the extensive premises of the school no fewer than sixteen *ateliers*, each let out to an approved master or *patron*, who is usually also the proprietor of a separate business in the city. To him are apprenticed for a term of three, or in some cases four, years some ten or twelve boys, all of whom at the end of that time will be able to take good positions as intelligent workmen. The trades thus taught are those of carpenter, wood-carver, turner in wood, optical turner, compositor, printer, wood-engraver, map-engraver (on stone), marble-mason, brass-worker, bookbinder, carver and gilder, clock-maker, portmanteau-maker, philosophical-instrument maker, and maker of wind instruments. The master of each separate *atelier* provides the materials, devises the work of the apprentices, superintends its execution either personally or by an authorized *contre-maître*, and to him belong the products of the workshop. Nothing is made in the shops that will not sell; the apprentices learn the value not only of materials but of time; and, though the works that successfully pass under their hands are graduated to their capacity and experience, they are precisely of the same character as those which apprentices in any ordinary workshop would have to undertake. The masters and foremen of the various *ateliers* appear to take great interest in their pupils, and pride themselves on the success of their instruction. "These boys," said the foreman of the portmanteau-makers, "when they leave this room know the whole mystery of their trade from end to end. They can take the *brute* materials, and from them evolve a finished article." The apprentices of this same shop will earn at once from five to six francs a day, instead of the two, three, or four francs usually earned by young workmen just out of their time. They work as quickly as other workmen, for they know from the exigencies of their particular work that time is money. Several of the *patrons* and foremen of the little workshops are themselves former pupils of the establishment. The apprentices earn nothing during their term of service beyond a little pocket-money when they are satisfactorily advanced. During the whole period of their apprenticeship their parents must contribute thirty francs a month for their board and lodging in the school. Great importance is attached by the *Frères* to the complete isolation from exterior influences insured by this internment. The magnitude of the work will be understood when it is learned that the income and expenditure of this establishment amounted to about two hundred and thirty thousand dollars in the past year, the services of the fifty worthy *Frères* who conduct the school being given at a purely nominal rate. There is a large gallery in the building for drawing and modeling, and excellent systems of instruction in model drawing and geometrical drawing have been here developed. Spacious refectories, commodious well-ventilated dormitories, and a large gymnasium form features of the school. The results of the system are significant. The aim of making intelligent workmen is really attained, and though the

pupils have learned but one *métier*, and are in general better adapted for small businesses than for large, their repute for steadiness, skill, and general intelligence is such that the *patrons* have little difficulty in placing their pupils when their term of apprenticeship is over, and usually in circumstances where their earnings are about the average. The same testimony is borne everywhere concerning the apprentices of this establishment; and the writer was informed by M. Véver, President of the Syndical Chamber of Jewelers, of Paris, a gentleman greatly interested in the question of technical education, and possessing every opportunity of forming an accurate opinion, that the boys of Saint Nicolas are so much more intelligent and steady than the average of workmen that they are sought for by employers, and at the age of thirty have usually risen to the position of foreman or master.

The third type of apprenticeship school is that of the *École Professionelle* attached to the large and flourishing printing establishment of MM. Chaix et Cie. This school, founded in 1862 by M. Napoleon Chaix, receives two groups of pupils, the apprenticed compositors and the apprenticed printers of the house. The schoolroom and the apprentices' composing-room, though contiguous to and overlooking the great busy *atelier* of the firm, are distinctly separate from it. The apprentices, of whom there are between thirty and forty, devote most of their time to the practical work of composing, two hours a day only being allotted to lessons in the schoolroom. Apprenticeship lasts four years, during the whole of which time the apprentices receive wages rising from fifty centimes to two francs fifty centimes for the compositors; and for the printers, who work at the machines in the great *atelier* under the direction of a responsible master, from seventy-five centimes to four francs fifty centimes a day. The teaching comprises a special primary course for those whose previous schooling has been insufficient; a technical course, including grammar and composition, reading of proofs and correcting for the press, the study of different kinds of types, engraving, and the reading and "composing" of English, German, Latin, and Greek—in the two latter cases from a purely typographical point of view, without any attempt to understand or to translate; lastly, a supplementary course which includes the history of printing, simple notions of economics, a little mechanics and physics, and a smattering of chemistry, dealing chiefly with the materials that they will hereafter employ—acids, oils, fats, carbon, soda, turpentine, etc. Everything is done with the utmost system. Every line set up by a pupil is, if possible, so much contributed to the current work of the firm; and, as time exercises are frequent, the value of rapidity in work is learned. At the end of the apprenticeship the pupils elect—almost without exception—to become employees of the firm, and enter at once into the rank of participants in the yearly division of profits. Of nearly seven hundred persons employed, two hundred and fifty-eight

are now participants, of whom about eighty are past apprentices. A much larger portion are depositors in the *caisse d'épargne*, or savings bank, established by the firm, or are "insured" in its books. Even the youngest apprentices put by a portion of savings out of their small earnings. The principals of the house fear no strike now, as there are enough participants in the wealth of the house to carry on its business through a crisis. "*La maison pour chacun, tous pour la maison*," is inscribed in gold on one of the beams that cross the great *atelier*. The sum thus divided among the employees in 1878 exceeded ten thousand dollars. The financial results of these arrangements, at once educational and prudential in their nature, are most encouraging. M. Berger, the accomplished inspector of this department of the enterprise, attributes the substantial growth and prosperity of the business, now one of the largest and wealthiest in France, as much to one influence as to the other. He prides himself on the superior intelligence of his pupils and their technical knowledge, gained while they are in the very midst of a great business, and thus forced even to realize and keep *au courant* with commercial exigencies. The few who have gone out to take places elsewhere are also doing well.

The fourth and last of our typical schools is the École Municipale d'Apprentis, which since 1872 has been at work in the Boulevard de la Villette. No school has produced more striking results as yet, and none merits more careful attention. Beginning with seventeen pupils in 1872, it now numbers a following of two hundred and twenty-one. The course lasts three, or in some cases four, years. It speaks volumes for the efficiency of the school that, out of seventy-two who, up to the end of 1877, had completed the course and gone out into situations, sixty-nine are at the present moment pursuing the trade they have learned in the school, and are earning on the average four francs a day —some of them even as much as six and a half francs a day. A school which can receive young lads of thirteen or fourteen, and after a three years' course can turn out workmen at the age of sixteen or seventeen able at once to command wages of twenty, or, in some cases, thirty-three shillings a week, is something so wholly new that its organization merits the most profound study. Founded on the suggestion of M. Gréard by the then Prefect of the Seine, M. Léon Say, at the expense of the city of Paris, it began its work in premises previously used as a factory of aneroid barometers, additional schoolroom accommodation being obtained in the adjacent dwelling-house. The object of the school is simply to make *good workmen*. The education it offers is absolutely gratuitous, and even remunerative to the pupils, for they receive every week a "gratification" varying from a franc and a half to three francs. None of the pupils are boarders. None are admitted until their primary education is completed, and then only after an easy examination. Five hours a day are given to studies, six hours to the work of the shops. The teaching of the schoolroom is both general and technical

in character, mechanics, physics, chemistry, and technology being added to the usual programme of literary routine, while drawing and modeling occupy a prominent place. The system of solid geometry taught in the schools is excellently conceived and admirably followed. M. Müller, the director, himself conducts this and some of the scientific branches of study. All the apprentices learn also to sketch bits of machinery or even entire machines, figure the sketch from actual measurement, and then with rule and compass draw them carefully to scale. There are two principal workshops, one devoted to the workers in iron, the other to workers in wood. The trades actually taught are forging, metal-turning, fitting, carpentry, wood-turning, and pattern-making. A small workshop for teaching the manufacture of philosophical instruments has also just been organized. During his first or preparatory year the apprentice, so called—there is, in reality, no formal contract—is making the round of the various shops, taking a fortnight in each in rotation. There is therefore no haste to specialize his work, and he has the opportunity of discovering the pursuit for which he is best fitted, while gaining information and intelligence. His first year over, he settles down to serious work in one of the six categories of labor: henceforth all the articles he makes are salable, and indeed of some value. Still, although the commercial element, eschewed in the Rue Tournefort, here steps in—to the profit of the municipality, be it said, rather than of the school—the apprentice does not sacrifice theory for practice. No single object must be attempted before the working drawing of it has been made out in plan and elevation; and the niceties of true surfaces and exact angles are scrupulously insisted on. Enter the forging and fitting shop, where over a hundred embryo workmen are busily, not to say noisily, employed, each on his all-absorbing task: they hardly look up as the stranger passes along. Here are three novices being taught to forge a hammer-head, learning to "strike," under the direction of a young foreman; and he *does* teach them, too, with a will. Here an older group are working out a piece by themselves at another forge. All down the long room are benches with vises, and in the middle the heavier machines, lathes, slotting-machines, and planing-machines—the latter designed and constructed only last year by the pupils themselves, and containing a valuable improvement first conceived in the brain of the able foreman of the workshops. Here, a large pinion is being turned; there, the parts of a vise are being filed into shape, while in the corner an apprentice of one week's standing is trying to file up into perfect form a simple square bar of iron fresh from the forge. After that he will pass to a task a little more difficult, following the course prescribed by experience. Almost all the tools are made by the apprentices themselves. The steam-engine which moves the heavy machines is under the charge of two pupils, of the second and third year respectively, their services being devoted for a fortnight to officiating as stoker and engineer. Healthy

and actively industrious the lads toil at their work, and three foremen suffice for the efficient superintendence of the hundred! Above is the carpenter's shop, where an equally numerous *clientèle* are equally hard at work. Here, too, we find originality of design and thoroughness of execution. Several of the machines—for example, a ribbon-saw—were made in the establishment, and were among exhibits of the school which attracted so much notice in the central pavilion of the Exposition Universelle of 1878. The first exercises in carpentry and in turning are literally exercises; useful to the last degree to their constructor, but of no marketable value. Here one realizes one advantage possessed by this municipal school over those in which the *atelier* is simply the workshop of a great business. In the early stages, when workmanship is very imperfect, it is not always well to strive to produce a salable article. Better waste wood, says the superintendent of the shops, than spoil the making of a good apprentice. Better to let the young workman see something of all the different corners of his trade, than by too fine a division of labor to keep him all his years learning only to shape chair-legs. And he is right, if the general look of intelligence and workmanlike style of his young charges afford any indication of their capability of well fulfilling the career they have chosen. From seven in the morning to seven in the evening are the hours of school, with an hour's intermission for dinner, and two shorter recesses. Work over, they disperse to their separate homes, for there is no boarding. M. Müller points out that the cost of setting up these shops, with all their tools and appliances, has been at the average rate of $55.75 for each of the one hundred and seventy-five places nominally provided in the accommodation of the school; while each of the present two hundred and twenty-one pupils, as he passes through the school, costs the municipality on the average an annual sum which is, as it happens, almost equal, namely, $55.50, instruction included. When the extensions of the buildings now in progress are completed, a very slight increase of total cost will suffice to extend the benefits of the school to a much greater number of pupils. The school property and furniture have already cost the city of Paris 750,000 francs ($150,000), including the lands and buildings, and the school is costing it 60,000 francs ($12,000) a year for working expenses. To set against this are the sums received for work sold, and the value of the instruments, models, and appliances fabricated in the school, and employed either in the school itself or handed over to one or other of the municipal schools, and which must amount to many hundred dollars yearly.

We have dwelt at some length upon this school, inasmuch as, regarded from the point of view of practical results, it appears to present by far the nearest approach to the ideal of an apprenticeship school. Not ignoring what is so valuable in consideration of the circumstance that the training is to be a preparation for after-life—the commercial value of the time and labor—it differs from the Institution

de Saint Nicolas in regarding the aim of producing good workmen as higher than that of establishing a self-supporting school. The Institution de Saint Nicolas is, thanks to the self-denying labors of the *Frères*, self-supporting so far as the *ateliers* are concerned, though the pupils pay for their board and lodging. The École Professionelle of MM. Chaix et Cie., which is but one example of a considerable number of similar establishments, is looked upon as one of the main causes of the prosperity of the concern. To establish such a school in any large business establishment requires little additional expense beyond the salaries of teachers. The École Communale is a most valuable experiment, and shows with what slender outlay some useful instruction in manual labor can be added to the resources of an elementary school. The École Municipale, with its kindred schools at Lyons and Havre, enable us to realize what an apprenticeship school may become if taken in hand by a rich and powerful municipality.

Turning once more to the conditions which obtain in our own country, the thought naturally occurs, Which of these very different types of school will best suit the requirements at home? On which line shall we proceed in our attempt to adjust to the altered social and industrial conditions of our time the apprenticeship of the past? Probably no one of these varied types will meet the thousand possible cases which may present themselves in the working out of the problem. Possibly there is room for all these types of apprenticeship school, side by side, or room even for new and untried types. One may adapt itself better to one locality or industry, another to another. Our business is not to copy, but to create and to develop for ourselves that which meets our own case. Much as will depend upon the character of each individual industry, all experience shows that there are other factors in the problem of scarcely less importance, and that much also depends upon the individual proclivities of the director of the school, the industrial enterprise of large firms, the far-sightedness of wealthy corporations. In France many of the schools have been initiated by the municipal or communal authorities. In Germany it is the town or the state that has made the venture. Will our town councils or our school boards ever think the experiment worth a trial, or is centralization too fierce and too frigid to countenance the attempt? All that is most valuable in the results obtained in the majority of the typical cases afforded by the Parisian schools can also be attained by private local enterprise, if guided wisely and well. Private local enterprise may surely hope for a success at least as great at home as that which it has already won across the Channel. And obviously the various industrial establishments know best the strength and weakness of their own resources. If a guiding and organizing central institution is needed, and it probably will be, it will be forthcoming so soon as there is work for it to do. But no central organization or institution can be expected to do the work which, at the outset, the local in-

dustries must initiate for themselves and develop by their own resources, and direct by the light of the consciousness of their distinctive needs. Then, and not till then, shall we able to form an exact estimate of the social and industrial conditions under which *the apprenticeship of the future* may become a living reality. Then, and not till then, will the apprenticeship of the future constitute a powerful instrument, not merely for the intellectual, moral, and social improvement of the working-classes, but for the promotion of the wealth and prosperity of the whole nation.

THE MIGRATIONS OF FISHES.

By Dr. FRIEDRICH HEINCKE.

THE periodical migrations of birds, grand as is the scale on which they are performed, and fitted as they are to excite astonishment, are insignificant compared with those which are made by the fishes of the sea. A faint illustration of the stupendous character of these movements is given off the west coast of Norway at the opening of the fishing-season in the spring, when one, looking out over the sea in quiet weather, will be witness of a stirring spectacle. The surface of the water as far as the eye can reach glistens in diversified colors; the fiords and bays are alive with silvery streaks playing in constant movement. The agitation is caused by the schools of herring, which are so closely packed that a boat can not pass through them, an oar may be made to stand up among them, and they may be dipped up in buckets or caught with the hand by the thousand. The enemies of the herring also come with them—the mackerel, the sharks, and the dolphins enlivening the scene with their graceful movements, with great flocks of gulls. The sprat also appear in great multitudes on the coasts of the North Sea, and the pilchards on the coasts of France and Spain and the southwestern coasts of Great Britain in such immense schools that millions of them have been taken with a single draught of a large net.

The fish of the family of the *Gadidæ* regularly visit the northern seas in innumerable hosts. The codfish come between January and March to the shallow bays of the Loffoden Islands and the banks of Newfoundland, where their fishery gives employment to more than ten thousand vessels and about one hundred and fifty thousand fishermen.

Codfish and herring belong entirely to the sea. Many other fish wander from the sea into the rivers. The sturgeon and the white-fish go from the Caspian Sea to the Volga to spawn in such numbers that, before the fishery became so destructive to them as it is, the children on the shore could scoop them up with their hands. Still more remark-

able are the schools of fish of the salmon family that resort to the great rivers of Siberia after the breaking up of the ice.

The resort of the fish to the same place is repeated every year with a wonderful regularity. The appearance of the herring in Norway varies at most not more than fourteen days. The energy of the movements is remarkable. The salmon, traveling from the sea to its spawning-places, surmounts considerable difficulties, leaping up to the tops of falls several feet high, and repeating its jumps if it fails at first, till it succeeds. Eels are able to ascend waterfalls forty or fifty feet high, and it has been asserted that they have been known to climb the falls of the Rhine at Schaffhausen; and since the sluices have been put down they have been able to pass the six falls of the Trollhätta, which have together a height of a hundred feet.

Fish travel to very considerable distances in these journeys. Brehm estimates that the salmon of the Obi and Irtish travel about 7,000 kilometres (4,340 miles) a year up and down the stream; and salmon and sturgeon often go from 1,500 to 2,400 kilometres (930 to 1,500 miles) from the sea to their spawning-places, and salmon to a height of 2,000 feet above the level of the sea. Salmon may occupy six or eight months in going up the stream and accomplishing their spawning, but will return to the sea in one or two months, traveling from ten to thirty kilometres (6¼ to 18¾ miles) a day.

Fish, like birds, return from the most distant journeys to the places of their nativity. This has been ascertained by marking individuals and watching for their return. This faculty of localization bespeaks a higher degree of intelligence than we have been accustomed to ascribe to fish.

The theories that have been proposed to account for these migrations have failed to give a fully satisfactory explanation of them. The migrations as a whole may be considered under five heads, of which the first and most important comprises the journeys to the places of spawning. The most notable instances of such excursions are those of the salmon tribe, and of the sturgeon, lampreys, eels, and tunnies. The proper home of all these fish, except the eel, is the sea; and, besides the eel, all of them except the tunny make yearly considerable journeys up the rivers to find places suited to the development of their spawn. Such places are, for the sturgeons, about the middle of the course of the river, in shallow, sandy spots; for the salmon kind, among the hills near the sources, or in the fountain-streams themselves, where the water runs in a lively current over a stony or gravelly bed. The lampreys ascend about as far as the sturgeons. Their young, which are very different in appearance from the parents, may be found in great numbers in nearly all the still brooks and ditches of the middle parts of the river-courses. The eel is the only European fish which goes from fresh water to the sea to spawn. Its journeys take place some time before the fish are ready to spawn, an abode in

the sea seeming to be essential to the ripening of the ova—a property which makes the study of the procreative functions of this fish more difficult. The tunny lives exclusively in the sea, but goes to the coasts of the Mediterranean, particularly to Sicily and Sardinia, to spawn. The sea graylings ascend the rivers of Spain and France in such numbers that the water seems covered with them.

The journeys of the fish in returning from their spawning-places after spawning are seldom performed in masses, but individually and in small groups. The fish, which went up fat and in fine condition and flavor, are exhausted, lean, and weak. Not much is known of the migrations of other fish than the salmon during these journeys, for the fishermen pay little attention to them and they therefore seldom come under the observation of science.

Next in order of the migrations are those of the young brood from their spawning-places. The young herring do not as a rule remain longer than four or five months where they are hatched. They then go down to the sea while the young eels go from the sea up to the rivers after about the same time. The young herring are observed with difficulty, for it requires a skilled eye to perceive their minute, transparent bodies in water that is in any degree disturbed; but in perfectly still water the schools may be seen moving to and fro like fine flecks of cloud. The salmon remain a full year in the mountain-streams, and do not go down to the sea till they have become a vigorous, greedy fish of about a finger's length.

Journeys in search of food are not periodical or regular, like the previous migrations, or are only incidentally so. The most important of them and the nearest to being periodical are the visits of the codfish to Newfoundland and the Loffoden Islands, concerning which it is as yet not certain whether they may not be partly connected with purposes of reproduction. Schools of other smaller fishes appear along with the cod, a salmonid, the herring, and a number of squids, which are all alike used by the fisherman as bait. The migrations of the predatory fish which follow the other fish in their spawning-journeys naturally partake of the periodical character of those journeys; the fish that pursue the herring follow them into the farthermost corners of the bays to which they resort.

The autumnal visits of mackerel to the Gulf of Kiel are of particular interest. They do not take place every year, and are not often marked by very great numbers, but they have attracted attention since 1624, when they were described by Schonevelde, on account of the peculiar character of the food that attracts the fish. The Gulf of Kiel is visited in August and September by great numbers of the *Medusa aurita*, which fill its waters, perform their reproductive duties, and perish on its shores, leaving hardly a trace of their watery tissues behind. In their maws swarm numerous individuals of a moderately large parasitic crab, and it is for the sake of these that the mackerel

throng in the bay, attack the Medusæ, and consume them. Mackerel feed upon minute crustaceans, chiefly copepods, which swarm on the surface of the water and often cover it, and follow them hither and thither as they are carried about by the currents.

The number of fish which lead an irregular vagabond life is not inconsiderable. Foremost among them are the sharks, which singly or in small companies will follow a ship for days at a time in order to snap up whatever may be thrown overboard from it. They are often accompanied by the pilot-fish, which has a peculiarly strong sense for food of all kinds, and directs the shark, is protected by him, and gets a share of the spoil. Other formidable fish, unsocial in their habits, being scattered over the ocean, are less accessible to science.

When more than the usual number of fish go up to spawn, the number of fish pursuing them is likely to be also increased. It sometimes happens thus, that species of fish which have not commonly followed the schools are attracted to them by the extraordinary abundance of food, and find their way to places where they were before unknown. Many fish are found in opposite quarters of the globe. The *Trachurus trachurus*, of the mackerel family, inhabits South American and Australasian as well as British waters. The sprat, common in the North European seas, has been discovered near the coasts of Tasmania, and thus lives at diametrically opposite points, while it has never been observed in the intervening seas. Inasmuch as migrations may often lead to a permanent enlargement of the domain of certain species, a knowledge of the laws and circumstances by which they are influenced has an important bearing on the study of the geographical distribution of species.

Migrations may also be performed under the influence of circumstances not connected with reproduction or the search for food. It is not certain whether fish are ever driven from their homes by a cooling of the water. Removals from such a cause would not take place in large masses, and might easily escape observation. As a rule, fish are not sensitive to changes of temperature, and can endure the greatest diversities provided they have food enough. Certain tropical fishes have a remarkable faculty of performing journeys by land. The climbing fish and an *ophiocephalus* of the East Indies and the *Doras costatus* of South America are able, when the ponds and swamps in which they live are dried up, to travel for several hours over the land to find places affording more water. The eel has been said to travel for considerable distances from one pond to another. It is certain that eels are able to live for a considerable time out of the water, and, though the fact has not been scientifically established, there is no reason to doubt that they can travel. The stickleback is often found in pools wholly unconnected with other waters. It may be that the eggs of the fish have been carried on the feet of waterfowl, or that the wanderers have found their way to such places during the rains of

the spring and fall, when the fields, the ditches, and even the wagon-tracks are running with water. Fish often remove from their abodes under the influence of circumstances unfavorable to their existence. If there is an unusual abundance of their food in one year, the number of fish will be greatly increased, to die of starvation as soon as the food is consumed. They are also often driven out in consequence of the pollution of the rivers, either dying or going to other places where the waters are more favorable to them. Whole communities in Norway and Sweden have been ruined by the sudden and unaccountable disappearance from their shores of the herring, on the catch of which they depended. In such cases the fish have sometimes absented themselves from their former haunts for a hundred years or more, while fishermen and students have endeavored without success to discover the causes for the change.

The conditions of a scientific explanation of the migrations of fish are not satisfied when we say that they take place in search of food or with the purpose of reproduction. We have still to ask what are the conditions connected with these objects which make necessary such extensive journeys. The answer is easy in cases where food is the object of the journey. The fish go where they can find the food that suits them. But why does the herring go to the shallows of the coast instead of leaving its eggs in the deep sea? Why does the salmon leave the ocean and go away up to the sources of the rivers? Experience gained in the artificial propagation of fish has partly helped to answer these questions. One of the most essential requisites to a good hatch of the eggs is a plentiful supply and free circulation of air. Hence it is necessary for the eggs to be laid in well-ventilated waters. This is impossible if they are spawned in deep water, where they will sink away below the reach of atmospheric movements. They must be deposited in waters that are disturbed to the bottom. Such waters are the shallows near the shore, where the herring lay their eggs, and the living streams, which are the resorts of the salmon and sturgeon. The fish, impelled at spawning-time to go in the direction of the most air, keep on till they find it in the places best suited for breeding. Different species of fish require different amounts of oxygen, the same as different animals do. The salmon and trout need much, and for it seek those waters which have the liveliest motion—mountain-streams. The opinion that these waters are more favorable to the development of the eggs because they are fresh is based on erroneous premises. Many of the species that commonly go to fresh waters also lay their eggs in salt waters, and even salmon sometimes lay them in the sea. Salt water really appears, from the most recent researches, to contain—other conditions being the same—more air than fresh. The same cause which impels the salmon to ascend to the lively, fully aërated streams of the mountains attracts other fishes from the deep seas to the shallows and rivers, and the eel from the bottoms of still-water

ponds to the wind-disturbed waters of the bays. Those fresh-water fishes that do not wander away, go to the well-aired spots in their neighborhood to spawn—to the shore-waters, the wet meadows, or the junctions of rivers, or to the tributary streams of the lakes in which they live. Those salt-water fish which live at the bottom likewise go to the waters near the shores, where the flats and the meadows swarm during the spring with their young. The eggs of the cod and mackerel are buoyed upon the surface of the water, where the winds blow constantly over them. The stickleback will swim before its nest and fan it with its pectoral fins by the hour. Thus every fish illustrates in some way the law that a constant change of air is essential to the development of its eggs. Agitated and sun-lighted waters are also most favorable to the larvæ of crustaceans and mollusks, of echini and polyps, and to the microscopic creatures of which the food of the fry chiefly consists, and thus fulfill another condition of the most vigorous growth of the young fish.—*Translated and abridged from Die Natur.*

DOMESTIC MOTORS.

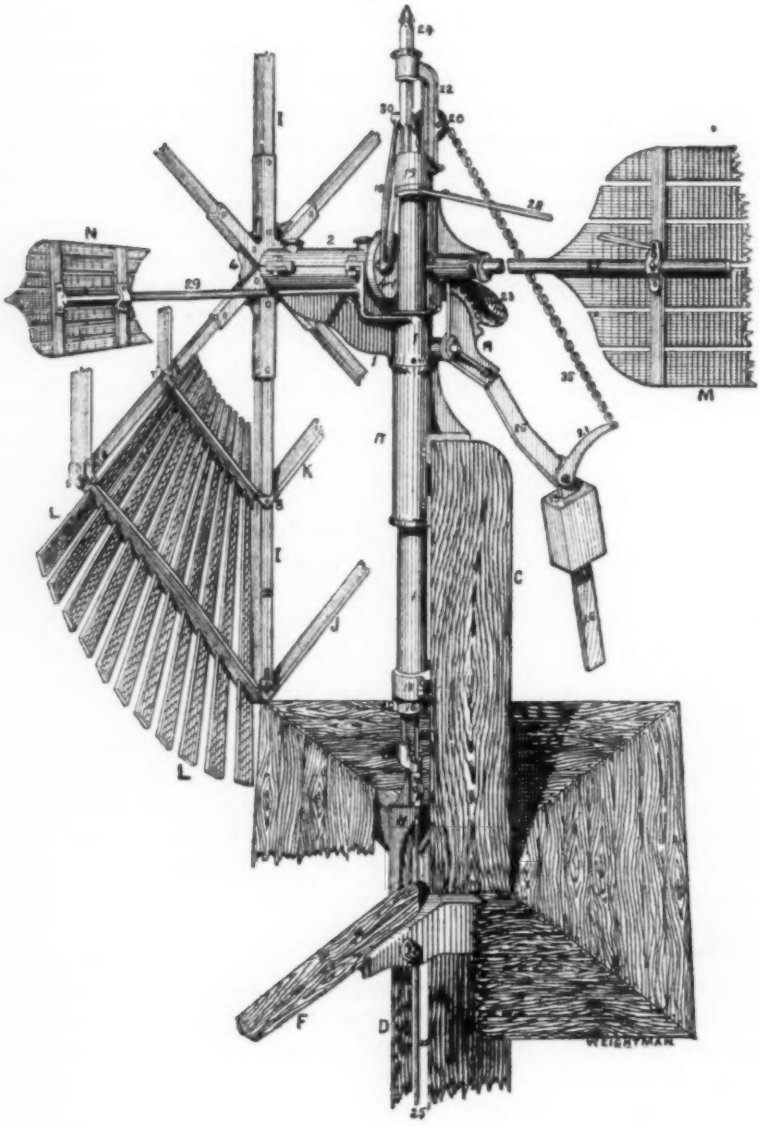
By CHARLES M. LUNGREN.

I.—WIND AND WATER POWER.

THE situations in which a motor of comparatively small power can be used with advantage, and in which it is a necessity even, are already very numerous and are constantly increasing. Not only has it a proper place in the workshop, in the business house, and on the farm, but in the household as well it has a wide range of utility. The need for such a machine in our homes, created by the sewing-machine, has been strengthened and increased by various other appliances in use or coming into use, while such devices as fans for cooling rooms in summer and ventilating them in winter further add to the requirement. In suburban and country residences, and on the farm, the primary need is for pumping water, and this alone renders a light and economical power almost indispensable. For the performance of most of the other mechanical operations upon the latter it is also of the utmost value. In the field of small industries the uses to which such a motor can be turned are as numerous as the varied occupations of the workers. The necessities of numbers of amateurs further increase the range of activity for such a power. The kind of machine that is suitable to the varied needs of these different classes of users necessarily differs in each. In most trades the demand for power is for one of from two to five horse and above, and on the farm a serviceable machine could not generally be much if any less; but in the

household that desired is rarely above one horse, and generally under it. A more complicated machine can, moreover, be used with success in the workshop than in the household, as in the latter it would gen-

FIG. 1.



erally be in the care of attendants but little, if any, skilled in the use of machinery. Certain general conditions are, however, common to all. The work for which it is needed is generally of an intermittent

character, and this necessitates a machine that will always be ready for work, or that can be made ready with but little trouble at short notice, and that is no expense, or but very small expense, when not being used. It needs further to be perfectly safe, economical in use, of low first cost, and to require but little care, and that of a kind which can be given by unskilled labor.

The attempts to make a machine that would answer to these varied requirements have been many, and they have been crowned with greater or less success. Though it can not be said that the ideal motor has been produced, still there are at present made and on the market a number of machines of real merit, and some of great excellence, that are all well adapted to the needs of users of light power, including the householder. While in large manufacturing only two machines—the water-wheel and the steam-engine—can be used, for the purpose of these small powers the range is much greater. Wind and water, steam, hot air, gas, and electricity, are all suitable and are all to a greater or less degree available. I propose in these papers simply to make a brief description of some of the more promising and successful machines now on the market, and give such information regarding the sizes in which they are made, cost of working, and prices, as will be of value to the householder and others having use for such a power.

Though the windmill is one of the oldest of the appliances by which man has sought to turn to his use the powers of nature, it remained until a comparatively recent period a very crude and cumbersome machine. In the earliest form, the wheel was fixed so that it could only turn when the wind was in the right direction; and later, when it was made movable, the shifting had still to be done by hand as often as the wind veered. Successive improvements were, however, slowly made, the chief ones being the addition of a rudder-vane placed directly behind the wheel in a vertical plane at right angles with its face, and a centrifugal governing device by which the canvas sails were furled and unfurled as the wind varied in strength. The pressure of the wind upon this vane automatically shifted the wheel into the wind, and the action of the governor presented to it a greater or less surface of the sails, securing a uniform velocity with varying wind-pressure. Even with these great improvements the windmill remained a clumsy affair until it was developed by American skill and ingenuity into the present very serviceable machine. As now made it is light and strong, and entirely automatic in answering to the varying direction and pressure of the wind. The canvas sails have given place to light wooden slats arranged radially around the wheel at short distances apart, and the whole mechanism has been simplified and vastly improved both in construction and design. The tower is an open-work structure of wood or iron, easily erected and taken down when desired.

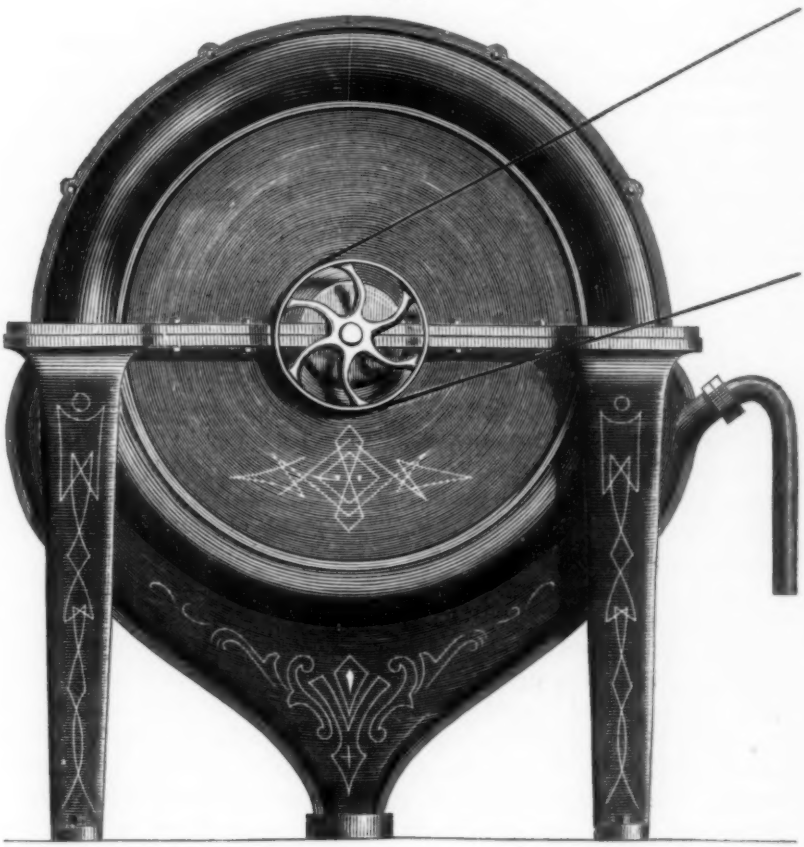
Two methods of regulating the extent of wheel-surface exposed to the wind are now in use, the one acting by centrifugal force as in Eu-

ropean mills, and the other by the direct pressure of the wind against a side-vane. In centrifugal mills the wind-wheel consists of a number of radial arms firmly secured in a metal hub, with sections between them pivoted so that they can swing into a position in which the ends of the slats only are exposed to the wind. They are held in the plane of the wheel by a counterweight, and thrown out of this position by the action of a ball-governor. This governor may be placed in various positions on the wheel, and act upon the movable section directly or through the medium of connecting rods. In one form of wheel the balls are placed upon the framing so that when the wheel is at rest they hang down upon its face, but as it revolves fly out, and in doing so turn the sectors. The angle at which the wheel-surface is exposed to the wind is thus altered with every variation in its velocity, and the motion of the wheel consequently kept nearly uniform, in a manner similar to that of a steam-engine. When the wind attains a velocity greater than a certain number of miles an hour, the action of the governor keeps the slats in the position in which their ends are alone exposed to the wind. The velocity at which the wheel will completely close can be regulated by the counterweight, which is movable on its arm by means of appropriate connecting rods, from the base of the tower.

This method of regulation has been found to answer very well in practice, but it has several grave objections. The construction is necessarily such that there are a large number of joints on which the wear is very considerable; and with so many movable parts the liability to derangement is greatly increased. The failure of any of the parts during a high wind would endanger the safety of the wheel, and perhaps cause its destruction. The second form of mill, that using the vane-governor, is much simpler in construction, has fewer parts, and is consequently more durable. It is, therefore, to a considerable extent supplanting the older form. The wheel in it is solid—that is, without movable sections—and is turned about a vertical axis in such a way that its angle with the direction of the wind varies with the pressure of the latter. The devices by which this is accomplished vary somewhat in different mills, but the method is essentially the same in all. In one, a small vane, placed back of the wheel, is hinged upon the frame of the large rudder-vane, and when the wheel is at rest hangs vertically downward. It is connected by means of rods with the wheel in such a way that, when the pressure on this exceeds a certain amount, the vane will be raised toward an horizontal position. In so moving it turns the wheel by suitable mechanism toward the rudder-vane. When the pressure of the wind is sufficiently great the small vane is raised to an horizontal position and the wheel swings parallel with the rudder. The whole apparatus, wheel and rudder, then becomes simply a weather-vane, is exposed as little as possible to the wind, and is in the best position to escape injury when this is very high.

The wheel can be adjusted to close at any desired wind-pressure by means of a sliding weight upon the arm of the small vane. It may be turned by hand edgewise to the wind by a chain passing to the ground. The working parts of another vane-governor mill of excellent design are shown in Fig. 1. A portion of the wind-wheel is represented at L L, the rudder-vane at M, and the small governor-vane at N. This latter is in a plane parallel with the face of the wheel, at a slight distance back of it, and extends beyond its edge. The wheel is supported upon an iron frame, 1, which turns within the tubing 17 and the additional bearing 18. The wheel-shaft passes through the

FIG. 2.



bearing 2 and gives motion to the pump-rod by a crank, 10, as shown. To one side of the frame 1 a weighted lever is pivoted, which terminates in a toothed segment. This gears with a curved rack on the frame of the rudder-vane, so that, moving the lever upward, the rudder and wheel approach each other. The chain 35 passing over the pulley 20

allows this to be done by hand when desired, through a lever upon the lower end of the rod 25. This movement is the one which takes place when the wind-pressure upon the small vane is sufficient, the wheel swinging round toward the rudder-vane an amount proportional to the pressure. When this pressure is great the wheel swings parallel with the rudder and presents only its edge to the wind, as in the case of the other vane-mill. The weight 13 is movable upon the lever 26, and the wheel is therefore capable of nice adjustment.

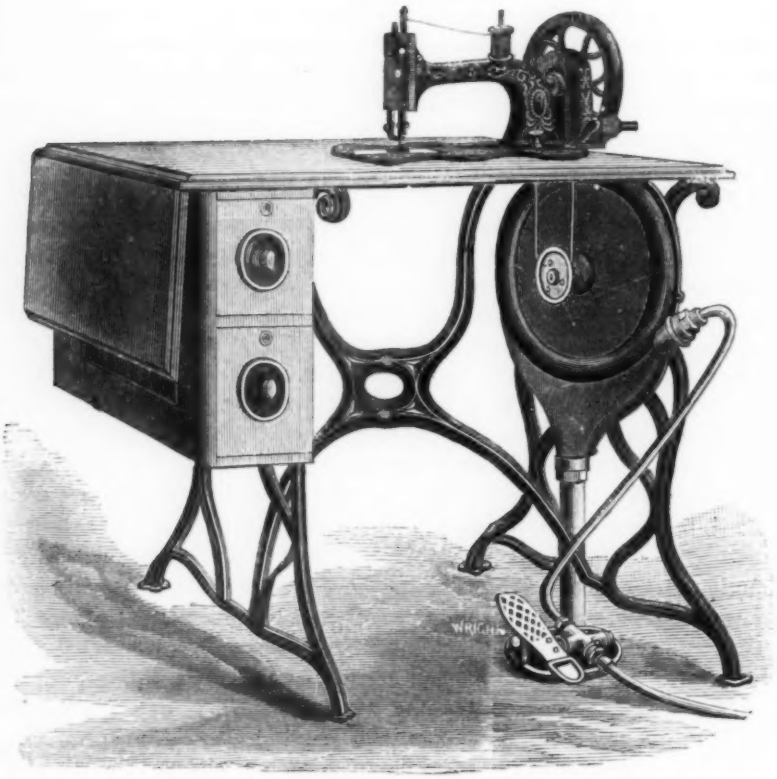
Windmills have gone very largely into use in the Western States, where the wind can be counted on with tolerable certainty. They are also used to a considerable extent in the East, both in the country and in the cities. Makers of wheels claim that in most localities they will work up to their full power seven hours out of the twenty-four, and a good portion of the remaining time will give some part of their full capacity. When a steady and continuous power is required, either at a definite time or whenever you happen to want it, the windmill is not suitable; but for all uses in which such conditions do not hold, such as pumping water, it is admirably adapted. It is for this purpose employed on railroads, the farm, country seats, and to some extent in cities where the water-pressure is insufficient to carry the water to the upper stories of buildings, as many as five hundred being employed in New York City alone for this purpose. On the farm it would seem that a mill might be employed for a variety of purposes besides the pumping of water. Such operations as sawing wood, chopping feed, and perhaps churning, might readily be done by wind-power, by timing them to the periods when experience showed it could best be depended upon. With a well-constructed automatic mill of from two to five horse, such work could probably be performed with less trouble than in any other way. The only expense after the first cost is that for repairs and lubrication, neither of which is large. The power of any wheel depends, of course, on the velocity of the wind. They are usually rated with the wind at twenty miles an hour, and on this basis the powers of those made range from one eighth to forty horse, the smaller size being eight and a half feet in diameter and the latter sixty. The first cost of a good mill is from twenty-five to fifty per cent. higher than a steam-engine of corresponding power, with boiler.

While the windmill is peculiarly well adapted for pumping and allied purposes, it is not at all suited to most of the uses for which a small power is required. Water-power, on the other hand, is excellently adapted to such uses. Water-wheels are simple, easily managed, and the most efficient of known motors. They are especially suitable for use in the household, and, where sufficient water can be procured under a proper pressure, are at once the cheapest and most convenient motor for the shop. Water-wheels of large power, such as are required in manufacturing operations, can only be used in particular localities; but those of comparatively small power can, owing to the very general

introduction of water under pressure into buildings in cities and towns, be used in very many places. As, however, the supply that most water-works are capable of furnishing is not at any time greatly in excess of the demand, wheels adapted for use upon house-pipes have to be, first of all, economical of water. They should also be constructed so that they are not liable to injury by water freezing in them, and be of low first cost. Several different wheels, designed to meet these requirements, are now made, and have been more or less widely introduced. One of the best of these, and one which has met with considerable favor in the market, is that shown in Fig. 2, the invention of Mr. O. J. Backus. It is exceedingly simple in construction, and has proved very satisfactory in use. It consists of a light but strong wheel, carrying buckets or vanes upon its rim, against which a jet of water impinges. The wheel is inclosed in an iron casing in which it revolves freely, the only points at which there is any friction being the bearings of the shaft. The manner of using the water constitutes the special feature of the motor, and is one that peculiarly adapts it to use on service-pipes, as it reduces the consumption to a minimum. In the wheels used in manufacturing, whether of the turbine or other pattern, motion is imparted by the continuous pressure of a considerable body of water. In this the motion is due to the successive impacts of a small jet having a high velocity, which allows of considerable work being performed with comparatively little water, as the striking force of the jet is utilized. In the smaller sizes of these motors, those capable of running a sewing-machine, the water-jet is but one sixteenth of an inch in diameter, while in the largest machines it does not exceed half an inch. A steady and uniform motion of the wheel is attained by placing the buckets very close together, so that the impulses follow each other in rapid succession. The water enters the wheel-casing at one side and escapes at the bottom, traversing but one quarter of it. As there is nothing to impede its flow, none can remain in the wheel and freeze in cold weather. The motors are manufactured in sizes varying from seven to forty-five inches' diameter of wheel, and from about one eighth to eight horse-power. The power obtained depends of course upon the pressure of the water, but they are designed to run at any pressure above fifteen pounds per square inch. This is easily obtained, as at most places where there are water-works there is a pressure of from twenty to forty pounds, and at some a much higher one. The manner of applying the motor to a sewing-machine is shown in Fig. 3. Perfect control over the supply of water is given by a valve operated by a treadle, which enables the operator to stop and start the machine as readily and quickly as by the ordinary foot-power. This method of regulating the speed of the machine has the great advantage that only the amount of power required is at any time used, thus saving the water to the utmost.

In a similar manner it can be used to drive any sort of light machinery, scroll-saws, dental engines, jewelers' lathes, coffee-mills, etc. One of the uses to which it is peculiarly well adapted is the blowing of organs. By a very simple mechanism the performer is given complete control over it, so that the bellows may be kept continually full. Among the heavier uses to which it has been applied are the running

FIG. 3



of printing-presses and the lifting of merchandise elevators in business houses. To all these uses it is in every way adapted, as it is always ready for use, is no expense except when running, needs no care, and is without danger. The extreme simplicity of the motor enables the makers to place it on the market at a very low first cost, varying from fifteen dollars in the case of the seven-inch to two hundred and seventy-five in that of the forty-five-inch double wheel.

The cost of operating these motors depends upon the locality in which they are used. In New York and Philadelphia the insufficiency of the water-supply prevents their use at all, but in most other places in this country they can be used at but nominal rates. The average

charge made by water-boards is from fifty to seventy-five dollars a year per horse-power, while for those used on sewing-machines the charge varies from three to six dollars. The cost for organs is between twelve and twenty dollars for the same time. When the motors are used for business purposes, their owners can usually get special rates depending upon the time they are actually employed. This price per horse-power is not greater than that of steam-engines of large size, and is very much less than the cost of any other form of motor of small power. This price is, however, based upon a condition of water-service which could not hold were the motors much more largely used than at present. The greatly increased demand for water that this would make would necessarily raise the price charged, but it could be very much increased and still leave these motors the most economical of small powers.

Another wheel of a somewhat peculiar construction, invented by Mr. Talley, is capable of being used either as a turbine or an overshot. The water is applied in such a manner that it strikes the wheel in a thin sheet, the sheet being undulating and wave-like in form, and impinging edgewise upon the wheel. The circumference of the wheel is provided with buckets set so as to make an angle of thirty degrees with the radial lines. The flanges forming the sides of the buckets are scalloped out to allow the water to freely escape when the wheel is employed in the former way. The wheel is set eccentric to its casing, approaching it closely on the inlet side. The casing in this portion has a number of curved channels terminating in the face opposite the buckets in a sinuous slit from which the water issues upon the wheel. The inlet-pipe enters this wave-line chute at the top of the casing, and the water is distributed throughout it by ducts terminating at different points. A valve at the top admits the water to one or more of these ducts as desired. The wave-line slit in the casing is wider near the top and gradually narrows toward the bottom, so that there is a greater weight of water on the wheel at the upper part, and the water issues with a higher velocity lower down. The sheet of water exerts a continuous pressure upon the wheel instead of moving it by successive impacts as in the case of the former motor. An outlet in the base allows the water to pass off when the wheel is used as an overshot, and one in the side of the casing provides an exit when it is used as a turbine. The wheel is said to be quite economical of water, and to run easily.

For light pieces of machinery, such as the sewing-machine, various sorts of spring motors have from time to time been devised, though none of them seem to have been brought into use. They are not properly motors, and are really quite valueless for the purpose of power, unless it be very slight, as that required in clocks. They are capable of giving out but a small amount of the power expended in winding them up, and, as this labor has to be done by hand, are very uneconom-

ical. A weight is a much better device, and yields a large per cent. of the power expended in raising it when it falls. Such an arrangement is, however, a thoroughly impracticable one, as a simple calculation will show. It takes about four hundred foot-pounds per minute to drive a sewing-machine, so that to run one an hour a weight of a fifth of a ton would have to fall sixty feet. The only practicable way of utilizing gravity for motive power is by the water-wheel, where the weight can fall continually, and the cost of raising it again is a minimum.

INDIGESTION AS A CAUSE OF NERVOUS DEPRESSION.

By T. LAUDER BRUNTON, M. D., F. R. S.

TO most men who are engaged in intellectual work, an autumn holiday has become a matter of necessity, and is not to be regarded as a mere luxury. During eleven months of the year many who are engaged in brain-work systematically overtax themselves, trusting to the month's holiday to bring them again into proper working order. Formerly this was not the case. Men seemed to be able to go on, not only month after month, but year after year, without any vacation at all. The circumstances under which they lived were different from those which exist now. The very means which facilitate our holidays—the network of railways which puts us into complete and easy communication with any part of the Continent of Europe, or the quick ocean-steamers which enable us to enjoy half of a six weeks' holiday on the other side of the Atlantic, as well as the telegraphic communications which will warn us in a moment, even at the most distant point of our travels, of any urgent necessity for an immediate return—all these are the very means which increase our labor during the greater part of the year. We live at high pressure; letters and telegrams keep us constantly on the *qui vive;* express trains hurry us miles away from home in the morning and back again in the evening, and the pressure of competition is so great that few men can afford either to take their work easily or to modify the constant strain of it by breaks of a day or two at a time. Wearied and exhausted, the hard-worked man goes off for his autumn holiday, and, if he can, will spend most of it in the open air, either yachting, walking by the seashore, strolling in the country, shooting on the moors, or climbing the Welsh hills or the Swiss mountains. After a month spent in any of these ways, the brain-worker comes back to town feeling himself a different man. Instead of his work being a slavery to him, as it was before he started, he feels it to be a pleasure; he gets through it with ease, and feels not only that the amount he can accomplish is greatly

increased, but that the quality is also improved. Perhaps for a short time after his return he is hardly in a condition to do brain-work at all. He sits down to his desk, but feels cramped in the unaccustomed posture, and he would rather work off the superabundant energy within him in a long walk or a stiff climb than restrain it with difficulty to the simple task of driving a quill. After a week or two he settles down and works steadily along with comfort and ease for a couple of months or more, when he again begins to sink below par. His apprehension is no longer so acute, his power of concentration is diminished, he can no longer fix his attention for any length of time upon one subject without a severe effort. His mental vision becomes less perspicuous, his ideas succeed each other more slowly, and find expression with greater difficulty, so that he communicates his thoughts with less fluency and less clearness than before. His temper, too, undergoes a change. Instead of regarding the daily occurrences of life with equanimity, and making the best of what can not be helped, irritation so slight as to be unfelt at other times provokes him to anger or peevishness, and even when he possesses sufficient self-control to restrain his feelings and prevent them from being manifested outwardly, to the annoyance of his friends or neighbors, the very effort of restraint seems to increase the internal irritation, until at last it either explodes in an ebullition of wrath on some comparatively trivial circumstance, or tells upon the digestion and nervous functions of the individual himself, diminishing the appetite or causing intense muscular weariness. In others, again, we find that along with or taking the place of irritability there is great mental depression. Everything is looked at from a gloomy point of view—himself, his friends, and his surroundings. He does not feel equal to his work; nothing that he does pleases him; he is apt to become distrustful of himself and jealous of others; apt to think that his friends are slighting him, or to fancy that he has offended them. Even when all external circumstances leave nothing to be desired, the unfortunate victim can not enjoy life. His mind is occupied with gloomy forebodings of miseries to come, or he becomes a prey to melancholy and depression without any apparent reason. This melancholy weighs most deeply upon him during the night, and if he happens to wake in the small hours of the morning, as he not unfrequently does, life seems not worth living, but a burden of which he would willingly be quit. Melancholy is at times associated with sleeplessness, and then the two evils react upon and increase each other. For this causeless sorrow has a similar effect to that of real sorrow. As Shakespeare says:

> "Sorrow's weight doth heavier grow,
> Through debt that bankrupt sleep doth sorrow owe."

At other times instead of sleeplessness there is an abnormal tendency to drowsiness, which sometimes comes on almost irresistibly at

the very moment when some important work, requiring all the best powers of the intellect, has to be performed, and rendering its performance either imperfect or completely impossible. As soon as the person goes to bed he falls asleep, and sleeps like a log till morning, when he rises with difficulty, feeling more exhausted than when he went to bed the night before, with perhaps a little tightness or pain over the forehead, eyes, or temples. After breakfast he feels somewhat revived, and will work comfortably for a short time, but about one and a half or two hours after the meal weariness overtakes him, again passing off after it has lasted a variable time. During the day this is repeated, fits of more or less energy alternating with periods of languor and exhaustion. These languid fits may be noticed two or three hours after lunch or dinner, and the sufferer is not unfrequently tempted to have recourse to the decanter of sherry or the brandy-bottle, not only to obtain relief from the feeling of personal discomfort, but to supply the energy which he feels to be necessary to enable him to do the work he has in hand. But this is a ruinous course to adopt, for not only does it pave the way to habits of confirmed drunkenness, and leads to tissue-changes which will ultimately abolish the functional activity of the most important organs of the body, and bring the individual to a premature grave; it enables him to do his work only imperfectly at the time. After an application to the decanter or bottle his powers may seem to himself to be as great as or greater than usual, but this is to a considerable extent a subjective feeling only, as he will probably be able to discover by results.

Now, how is it that such a change has come over the man in a few months, so that he seems to be a different individual from the one who returned, bright and lively, from his autumn holiday? How is it that the even-tempered man has become irritable, the clear-headed man muddled, the active lazy, the sober perhaps a tippler, and the cheerful and buoyant depressed and melancholy; that the brain performs all its functions with difficulty, and the mind is so altered that it does not seem to be that of the same individual? And yet, after all, the man is the same, and the brain is the same, at least in its essential structure, as it was a few months ago, and as it will be in a few months more, after another holiday has again put it in good working order. What has happened to it in the mean time to cause such a dreadful alteration? Not only does the brain seem exhausted, but the whole system appears to be languid and weak; instead of the man being able for a twenty or thirty miles' walk, one of a mile or two will produce fatigue, and sometimes an intense languor is felt without any exertion at all. And yet all this time he may have been trying to keep up his strength. He takes butcher's meat three times a day, perhaps also strong soups, to say nothing of wine, or brandy-and-soda, to pick him up. His tissues ought to be getting sufficient nourishment to enable them to do their work, and yet it is evident that they are not in a con-

dition to do so. The man, and very likely his friends also, wonders at his condition, and when he goes to his medical attendant to describe his case he says, "I take all sorts of strengthening things, and yet I feel so weak." If, instead of using these words, he were to say "*Because* I take all sorts of strengthening things I feel so weak," he would express a part at least of the truth. He and his friends who wonder with him forget that all the functions of life are more or less processes of combustion, and that they are subject to laws similar to those which regulate the burning of the coal in our fireplaces. Two things are necessary for the combustion, fuel and oxygen; sometimes it is the fuel that fails, but not unfrequently it is the oxygen. Sometimes, no doubt, our fires go out because the fuel is quite exhausted, but this is very rarely the case. It is only under very exceptional circumstances that we find a fire burned away so completely as to leave nothing but ash. Almost invariably some fuel still remains—often, indeed, enough to make up a good fire when properly put together. If we sift the ashes from the grate we generally find a quantity of cinders, sufficient to make a fire, and these have ceased to burn because they were unprovided with oxygen, which was prevented from reaching them by the ashes with which they were covered.

The reason why our fires burn low, or go out altogether, either is that we put on too much coal, or that we allow them to be smothered in ashes. It is the child who pokes the fire from the top to break the coal and make it burn faster; the wise man pokes it from below so as to rake out the ashes and allow free access of oxygen. And so it is with the functions of life, only that, these being less understood, many a man acts in regard to them as the child does to the fire. The man thinks that his brain is not acting because he has not supplied it with sufficient food. He takes meat three times a day, and beef-tea, to supply its wants, as he thinks, and he puts in a poker to stir it up in the shape of a glass of sherry or a nip from the brandy-bottle. And yet, all the time, what his brain is suffering from is not lack of fuel, but accumulation of ash; and the more he continues to cram himself with food, and to supply himself with stimulants, although they may help him for the moment, the worse does he ultimately become, just as the child's breaking the coal may cause a temporary blaze, but allows the fire all the more quickly to become smothered in ashes. It would seem that vital processes are much more readily arrested by the accumulation of waste products within the organs of the body than by the want of nutriment to the organs themselves. In all cases of fasting, whether voluntary or compulsory, life is prolonged to a much greater extent if water be freely supplied. Without water the individual quickly dies, however much other nourishment he may get, but with abundance of water he may live for a considerable time, even if he take no solid nutriment at all. Here it is not that the water acts as a food; it supplies no new energy to the body, for, unlike starch, or

sugar, or fat, or proteids, it has already undergone complete combustion. It can not, like them, unite any further with oxygen and thus supply energy.

And yet it is more essential to life than any of them, for without it the products of waste can not be removed from the tissues, and the vital fires, so to speak, are smothered in their own ash. If we take the excised muscle of a frog and stimulate it to repeated contraction, the contractions become feebler and feebler, until at last they cease altogether. But this is not because the fuel which the muscle contains in itself has been so completely burned up that none of it is left to furnish the requisite energy to the muscle; it is because the chemical processes necessary to the contraction of the muscle are arrested by the accumulation of the products of its own waste. If we wash these out of the muscle by sending through its vessels a weak solution of common salt, which supplies to it no new material, but which removes these waste products, the contractile power of the muscle will be restored.

This restoration takes place still more quickly and thoroughly if we employ a fluid which will supply oxygen, such as a solution of permanganate of potash, instead of a simple solution of salt, which merely washes out the muscular waste. The muscle is like a fire in the grate, which goes out long before the coal is entirely consumed, on account of the ash which smothers it, and just as we can revive the smoldering embers by supplying them with oxygen by the use of bellows, so the muscle revives more quickly when its supply of oxygen is increased. The quicker the fire burns the sooner will it be choked in ash, and the more rapidly the muscle contracts the sooner will it lose its powers.

The same is the case with the heart. The slowly beating heart of a crocodile will pulsate for a day or more after it has been cut out of the body, but the rapidly pulsating heart of a mammal will very soon cease to beat; and, the more rapidly it has been beating before the animal's death, the sooner will it cease to contract afterward. If the vagi are cut in the living animal so that the cardiac pulsations become excessively rapid, the heart's movement ceases almost as soon as the animal dies; but, if during life the vagi are irritated so as to make the heart contract very slowly indeed, it comes to resemble more nearly the heart of the crocodile, and continues to pulsate for a considerable time after the animal's death. The heart, too, resembles voluntary muscles, inasmuch as, if we wash out of it the products of its own waste, it will continue to beat for a much longer time than if we allow them to accumulate. By simply allowing a saline solution to circulate through the heart of a frog it may be kept beating for many hours longer than if it were left to itself. Both voluntary muscles and involuntary ones, such as the heart, cease to act, almost invariably, not by exhaustion of their energy-yielding substance, but by accumulation of the waste products within them; and muscles, both voluntary and involuntary,

are much less sensitive to this process of choking than the delicate structures of the nerve-centers. The gastrocnemius, or the heart of a frog, may retain its irritability for very many hours after its sepation from the body, but the spinal cord of the same animal will rarely retain its irritability for a single hour after the circulation through it has been arrested. In warm-blooded animals the spinal cord is much more sensitive than in the frog, and, if the circulation in the lower part of the spinal cord be arrested in a rabbit by the pressure of a thumb upon the aorta for three or four minutes, the hind-legs of the animal will become completely paralyzed. Still more sensitive than the spinal cord is the brain, and if the circulation in the latter organ be arrested, consciousness is almost instantaneously abolished. In the animal body as in the steam-engine, the governing and directing parts are much more sensitive and easily acted upon than the working parts. A single touch of the hand to the steam-valve will set the engine in action or stop its movement, although the power of a thousand men applied to the fly-wheel would avail little or nothing. And in animals the nerve-centers are most sensitive and respond most readily to those circumstances which affect the organism. Not only are they exceedingly sensitive to the accumulation within them of the products of their own waste, but they are easily affected by alterations in the blood which circulates through them, and which conveys to them not only the products of muscular and glandular waste formed in other parts of the body, but also substances introduced from without, or absorbed from the intestinal canal. A single whiff of nitrite of amyl is sufficient to dilate the blood-vessels ; a fraction of a grain of pilocarpine will stimulate the sweat-glands to the most profuse secretion ; and half a drop of pure hydrocyanic acid is enough almost instantaneously to abolish consciousness and destroy the functional activity of the entire nervous system. In the case of the nitrite of amyl, the pilocarpine, or the hydrocyanic acid, we are able to distinguish the relation of cause and effect between the administration of the drug and the resulting changes in the organism. We do this, however, because of our knowledge, obtained by observation and experiment. Sometimes we can not do this. I have seen, for example, a person become aware of a peculiar sensation which, to the patient, was quite unaccountable, but of which I understood the reason, as I knew it to be due to the fumes from a bottle of nitrite of amyl, which the patient could not see. We may notice a similar occurrence in poisoned animals. The poison of the cobra causes paralysis of the spinal cord and nerves, and induces intense weakness, so that the limbs of the animal fail under it. I have seen an animal in this condition attempt to walk, and look round at its legs with a puzzled air, as though it could not understand what was the matter with it. It could not connect the weakness in its limbs with the introduction of the poison some time previously, although the connection between them was to me perfectly clear.

In the same way as the action of the cobra-poison was a mystery to the animal, an epidemic of typhoid fever was formerly to us a mysterious occurrence for which no reason could be assigned, but we now trace it to the absorption into the bodies of the sufferers of typhoid poison introduced from without. We are now completely alive to the important results produced by the absorption from the intestinal canal of poisonous matters, such as typhoid-germs, arsenic, or strychnine introduced into it from without. But perhaps we are not yet sufficiently alive to the important results produced by the absorption from the intestinal canal of substances generated in it by fermentation or imperfect digestion. We recognize the danger of breathing gas from a sewer, but probably we do not sufficiently realize that noxious gases may be produced in the intestine, and, being absorbed from it into the circulation, may produce symptoms of poisoning. And yet we know, from recorded observations, that such is the case, and that one at least of the chief components of sewer-gas, viz., sulphuretted hydrogen, may be produced in the intestine. This gas, which is so readily recognized by its smell resembling rotten eggs, was found by Dumarquay * to be very quickly absorbed indeed from the intestine when injected into the rectum, and to be quickly excreted from the lungs, sometimes appearing to produce, during its elimination, some inflammation of the trachea and bronchi. This was especially the case when small quantities were injected, and it seems not improbable that the production of this gas in the intestine may have something to do with the bronchitis which is not unfrequently observed in connection with digestive disturbance. In cases of indigestion this gas seems to be not unfrequently formed, because persons often complain of the taste of rotten eggs in the mouth or in the eructations. Even in such small quantities it is not improbable that it may exert a deleterious influence both upon the nervous system and upon the blood, for it is a powerful poison, in its action somewhat resembling hydrocyanic acid, though not so strong. It destroys ferments, and robs the blood-corpuscles and the seeds and roots of plants of their power to decompose peroxide of hydrogen ; and, as this faculty seems to be closely associated with the processes of life, the sulphuretted hydrogen may be regarded as a powerful protoplasmic poison. Upon plants it has a curious action, differing very markedly from sulphurous acid. When plants are exposed to sulphurous acid, the leaves shrivel up, wither, and fall off, but, if the plant be now removed from the noxious influence of the gas and placed under favorable conditions, it will recover and send out fresh shoots. But, if it be exposed to the action of sulphuretted hydrogen, the leaves, instead of shriveling, simply begin to look flaccid, and droop. This seems, at first sight, to be a less deadly action than that of the sulphurous acid, but when the leaves have once begun to droop in this way the plant is dead, and does not recover when re-

* "Comptes Rendus," ix, p. 724.

moved from the action of the gas. This gas is rarely generated in the intestine in such a quantity as to give rise to symptoms of acute poisoning, but it has sometimes this effect. A case is recorded by Senator* in which a strong and previously healthy man became affected with a slight gastro-intestinal catarrh in consequence of some error in his diet, and on the second day afterward he had frequent eructations, smelling strongly of sulphuretted hydrogen. At the same time he suddenly became collapsed, pale, giddy, and with a rapid, small, compressible pulse. This lasted for one and a half to two minutes, and then passed off. The urine which he passed shortly afterward contained sulphuretted hydrogen. On the same day he had a second attack of a similar sort, and then, the bowels having been opened, he recovered completely. Nor is sulphuretted hydrogen the only gas which may be formed in the stomach. Marsh-gas is sometimes formed there too, and, in an exceedingly interesting case recorded by Dr. Ewald,† the quantity was so great that it first attracted the patient's attention by taking fire as it issued from his mouth while he was lighting a cigar. In this curious case the formation of gas alternated with the production of a great quantity of acid fluid in the stomach, which led to vomiting, or, as the patient himself expressed it, sometimes his gas-factory and sometimes his vinegar-factory was at work. It is possible that this gas may be formed in small quantities in many more cases than has hitherto been suspected, but its absorption does not seem to have anything like the same deleterious action as that of sulphuretted hydrogen. Nor was the acetic acid which was found by chemical analysis to exist in the acid secretion of the stomach in this case likely to be productive of any injurious effects after its absorption. But butyric acid, which is sometimes formed in the stomach in other cases of indigestion, has been shown by O. Weber to be a powerful poison acting chiefly on the nerve-centers.

It seems probable, however, that the substances, both gaseous and solid, formed in the stomach and absorbed from it, are upon the whole less poisonous in cases of indigestion than those which are produced lower down in the intestinal canal. We often find that patients are affected with severe gastric disorder without any affection of the nerve-centers beyond the weakness produced by the inability to digest food, while in many persons the mere omission to evacuate the contents of the bowels at the usual time will lead to a headache in the course of the day. No doubt such a headache as this may be due, to some extent, to the nervous irritation caused by the presence of the fæces in the intestine, but it seems quite possible that it is also due to the absorption of some of the fæcal matter itself. Nor do we at present know what effects are produced by the absorption of the various digestive juices themselves. That such absorption takes place there can be

* "Berliner klin. Wochenschr.," 1868, No. 24.

† "Reicherts und Du Bois-Reymond's Archiv.," 1874, p. 217.

little doubt. It has been demonstrated in the case of the bile, which is absorbed with great rapidity from the intestine and reëxcreted by the liver, so that it does not pass into the general circulation at all. But what becomes of the other digestive fluids, and the ferments they contain? The pepsin finds it way in minute quantities through the liver, and has been discovered in various tissues of the body and in the urine. This, however, matters but little, for it can not act upon the tissues themselves, inasmuch as they possess an alkaline reaction. But the case must be somewhat different with pancreatine, and if pancreatic fluid be absorbed from the intestine and pass through the liver unchanged, we should expect that it would have a very powerful action upon the tissues throughout the body, because there appears to be no reason why it should not act upon them just as it does upon the food in the intestine itself. It seems not at all unlikely, then, that the liver has got another function besides those usually assigned to it, viz., that of preventing the digestive ferments from reaching the general circulation so as to act upon the tissues. Now, we do find in the liver itself and in the bile a ferment having the same diastatic power as the pancreatic juice, but it does not appear in such quantities as one would expect if the whole of the pancreatic ferment were simply reëxcreted by the liver along with the bile, and, as we have no evidence that the ferment is destroyed during its action in the intestine, we are naturally led to think that it may undergo a change in the liver, the converse of that which it undergoes in the pancreatic gland during the process of secretion. In the pancreas itself we have no ready formed ferment, but we have a ferment-forming substance, which has recently become known under the name of zymogen, given to it by Heidenhain, but the writer heard it described by Kühne in his lectures on physiological chemistry delivered at Amsterdam in 1869. I quote verbatim from the notes which I took at the time of his lecture on the pancreas: "Glands which have no action on fibrine can be made active by digesting in very dilute acid and then neutralizing or alkalizing; there seeming to exist a ferment-forming substance in the pancreas." During digestion this ferment-forming substance or zymogen splits up and yields free ferment, and it seems not improbable that it is in the liver that this very ferment, after its digestive work is done, becomes again converted into the ferment-forming substance which may circulate throughout the tissues without doing them any injury.

Whether this be the case or not, however, with regard to the ferments of the gastric, pancreatic, and intestinal juices, all of which must pass through the liver before they reach the general circulation, there can be no doubt that the products of intestinal digestion do undergo very marked changes indeed in the liver, as is shown by the formation from them of very large quantities of a new substance, glycogen—a substance which is not contained in the products of the gastric and intestinal digestion which reach the liver, and yet which

is of the highest importance for the nutriment of the body. Under ordinary circumstances, nearly the whole of the sugar formed in the intestine and absorbed from it is arrested in the liver, so that very little passes into the general circulation and appears in the urine, although even in healthy persons traces of sugar are excreted by the kidneys. Under exceptional circumstances, however, sugar may pass through in considerable quantities, as, for example, when the individual takes, on an empty stomach, a large quantity of sirup. However healthy his organs may be, sugar will then appear in the urine. The same is the case in regard to albumen. Usually, the whole albuminous constituents of our food are so transformed in the stomach, intestines, and liver, that no albuminous substances of the kind which can pass through the kidneys get into the general circulation. But, if one takes such a quantity of eggs as to completely overtask the digestive powers, the egg-albumen will pass unchanged into the blood, and be excreted by the kidneys.

Other albuminous substances, the products of intestinal digestion, and peptones also, occasionally make their appearance in the urine, as well as egg-albumen. Even when the processes of assimilation are not so seriously interfered with as in these instances, we observe that products of nitrogenous waste frequently occur in the form of lithates in the urine. An excess of these indicates some pathological condition, even although it may be very trivial. We can not, indeed, say what the exact condition is, because we find lithates appearing in the urine after violent muscular exertion accompanied by profuse sweating, so that they may possibly represent some of the products of muscular waste; but we also find that they occur in large quantities in the urine after slight indiscretions in diet, although no muscular exertion has been undergone, and in these cases we can hardly do otherwise than regard them as products of the imperfect assimilation of nitrogenous matters which ought to have been eliminated, not in the form of urates, but of urea. Now, physiological experiments and observations indicate that the liver is the chief if not the only part of the body in which urea is formed. This at least appears to be the case excepting in febrile conditions, in which, possibly, the urea may also be formed, to a considerable extent, in the muscles. The old notion, then, which connected the appearance of lithates in the urine with disordered function of the liver, is probably in a great measure correct. There is little or no reason to believe that these lithates are formed in the kidneys. They are, probably, simply separated by them from the blood, and their presence in the urine would therefore indicate their presence in the blood and tissues. Now, lithates in themselves do not appear to have any particularly injurious effects, either upon the nervous tissues or the muscles, but, as their presence indicates deficient assimilation, they may be accompanied by other substances which have a much more pernicious action, just as there are

many bad smells which, *per se*, though very disagreeable, have no marked poisonous action, while other very poisonous substances have comparatively little odor.* Yet the disagreeable odors which accompany sewer-gas, although perhaps not always dependent upon its poisonous constituents, warn us of the presence of gases which may be intensely poisonous. Nevertheless, just as the poisonous gases may be present without any disagreeable smell, so we may have substances circulating in the blood which have the most injurious effect upon the nerve-centers, without the presence of urates in the urine.

The importance of the functions of the liver in reference to assimilation is now generally recognized, although for a long time this, the largest gland in the body, was considered to have no other office than simply to secrete bile. Although the bile is useful in digestion it is not of primary importance in this process ; but its proper secretion is probably associated very closely with the assimilative functions of the liver, and if the biliary secretion does not take place properly we can hardly expect the assimilation to be perfect.

The greatest care appears to have been taken in the construction of the liver to prevent the bile from coming in contact with the blood, the ultimate radicals of the bile-ducts or biliary capillaries being placed as far from the blood capillaries as the structure of the liver will allow. Notwithstanding this care, the distance between the blood and the bile capillaries is small, though it is sufficient, under ordinary circumstances, to prevent the absorption of bile into the blood. But whenever an obstruction takes place to the exit of bile, and the presence of bile in the biliary capillaries increases, an absorption of this secretion occurs. Bile is secreted under very low pressure, and a very slight increase in this is sufficient to cause reabsorption. Such an increase as would not materially affect the secretion of other glands, such as the salivary gland, is sufficient to prevent the exit of bile through the biliary ducts, and cause its reabsorption into the blood. The excretion of bile is greatly aided by the pressure which is exerted upon it by the movements of the diaphragm during respiration, and indeed so low is the pressure under which the bile is secreted that, but for the assistance given by the respiratory movement, it would just barely find its way into the duodenum. Although we are accustomed to say "as bitter as gall," according to my own observations fresh human bile is not bitter. When it is thrown up in consequence of indigestion it is intensely bitter. On one occasion, when making experiments with digitalis, I had taken in the course of two days one grain of the pure alkaloid, and brought on symptoms of poisoning, with intense vomiting. During this I brought up a quantity of bile of a golden-yellow color, and without the least trace of bitterness. This circumstance struck me as being so peculiar that in my published results I hesitated to call it bile, although I did not

* Brunton and Power, "St. Bartholomew's Hospital Reports," 1877, p. 283.

see what else it could be.* But when it remains long in the gall-bladder it undergoes changes, and in some cases of vomiting that I have seen the vomited matters have been of a bright grass-green color. When examined, also, after death, the bile in the gall-bladder is not unfrequently found of a dark color, and the same is probably the case when it is retained in the gall-bladder for any length of time during life. How the Greeks arrived at the notion of giving the name "melancholy," i. e., black bile, to depression of spirits, we do not quite know, but certain it is that depression of spirits is very often associated with indigestion, and, moreover, that the form of indigestion with which we find depression of spirits associated is not so much gastric as intestinal, or, more probably, hepatic. According to Herbert Spencer, we require rapid evolution of nervous energy in order to have exhilaration of the spirits, and depression of nervous energy is associated with melancholy. Now, the effect of bile-acids circulating in the blood, as shown by physiological experiments, is to depress the reflex function of the spinal cord, the functions of the brain also, producing drowsiness ending in coma, and also weakening the circulation by paralyzing the cardiac ganglia.† Such a combination of actions is just the one required by Mr. Spencer's hypothesis to produce melancholia, and here we find ancient notions joining hands with modern science. —*Practitioner.*

ORIENTAL MUSIC.

By S. AUSTEN PEARCE, Mus. D., Oxon.

INNUMERABLE questions arise in the mind whenever that mysterious art, called music, occupies our thoughts—questions respecting its source, its course or development in various epochs, its laws, object, action, limitations, and influence. These are not easily answered satisfactorily, and appear to have been as great problems to the ancients as they are to ourselves. For, attempting to penetrate the thick mists that veiled their past, they failed to discover the origin of any one musical instrument ; and being completely baffled in their researches concerning the inception of musical systems, and also unable to account for the remarkable sway that their art-works exercised over hearers, they contented themselves with conserving these systems and art-works in their entirety, for the benefit of posterity.

We, who are always ready to invent theories for the explanation of phenomena, find ourselves extremely perplexed in accounting for various musical facts that at first sight seem simple and easily understood.

* Brunton "On Digitalis," p. 67.

† *Vide* Wickham Legge, "Bile, Jaundice, and Bilious Diseases," pp. 207, 216, 217.

If, therefore, we are unable to explain our music to ourselves, and the ancients could not explain their music to themselves, it should not cause surprise if we fail to comprehend their music. For, although it is said, "Human nature is the same in all ages," the tonal art, which appeals to every individual's own inner nature so very directly and intimately, reveals strongly marked differences among men.

The difficulties to be overcome in forming an adequate conception of the music of other peoples are, therefore, great. If, after persistent effort or even a life-long devotion to performance and composition, we find perplexing mysteries at every turn, we may naturally anticipate encountering inscrutable enigmas in the endeavor to comprehend the true nature of the forms of art specially adapted to the necessities of races so far removed in time and place, thought and feeling, as the ancient Orientals.

Even the music of the modern occupants of the East is so strange and foreign to our wants and inclinations, that many persons speak of it with disrespect; and travelers and generally well-informed artists, judging of its merits by the casual performances of poor peripatetic musicians, are frequently led to the belief that it is unworthy special regard. It would be more philosophical to assume that an art practiced throughout the Orient by all classes of persons, in all times, would, if seriously studied, present many aspects worthy of deep reflection. However little we may be able to sympathize with Chinese, Hindoos, Persians, and other peoples in their artistic aspirations, we should not be tempted to provoke a smile at their expense, but approach the study of their music with the greatest respect. In this spirit let us proceed.

Music and its instruments were commonly believed in the East to be gifts from Heaven, and therefore its cultivation and their preservation became religious duties. The Orientals took no credit to themselves for inventing the various extraordinary instruments with which they performed their wonder-working melodies, and, as will be presently shown, no modern nation has yet invented a really new one; for all those we employ are either enlarged or simplified forms of prototypes that were in use at the earliest times of which we have any record, and are really prehistoric.

The sacred books of the Chinese give a complete account of their organ—most exact measurements of the lengths, diameters, thickness, materials, etc., of each pipe, and so on—not to suggest improvements, or take credit for the devices mentioned; but simply that, should the instrument from any cause become obsolete, it could be revived; and thus this great gift, from some remote ancestor, would still be secured for future generations. Confucius and various emperors are portrayed performing on the *kin* (a stringed instrument), and music occupies the first rank among the sciences.

In India, Brahma himself is believed to have presented music to

mortals, and the invention of the seven-stringed *vina* is attributed to the god Nareda. Saraswati, the Minerva of the Hindoos, is represented playing on the lute, Krishna on the transverse flute, and harpists are adorned with wings.

In Egypt, the formation of the three-stringed lyre is attributed to one of the secondary gods. Osiris is regarded as the giver of the flute, Isis of songs, and Thoth of musical theory. In Egyptian hieroglyphics the *nofre*, a long-necked stringed instrument played with the hands, is labeled "good." In a satiric papyrus, now at Turin, Rameses III, as a lion, is playing chess with a favorite, figuring as a gazelle; and in another papyrus in the same collection these characters reappear playing respectively a lyre and harp, a crocodile is performing on a *nofre* and a slave on the double pipes. Music occupied a much more important place in the religion and daily life of Eastern peoples than it does among ourselves, where it is often regarded as an ordinary amusement or diversion, and unworthy any higher function. Hence the unwillingness so commonly manifested by very many religionists, having the best possible intentions—who accept the Bible, and think they regard all its teachings—to be cross-questioned with reference to their belief in its many statements respecting this art. They find the sacred writings of the Hebrews bearing testimony to its worth and power as well and fully as those of other ancient nations, and that not only the Jews (who were always extremely fond of and susceptible to its influence) are addressed, but also succeeding Christians; for, according to the New Testament, the blessed ones in heaven are unceasingly occupied in music.

The Hebrews were taught that Jehovah gave Moses special directions for the making of silver trumpets and a code of signals. They were allowed to mend musical instruments in the Temple on the Sabbath-day; believed the art to be efficacious in curing mental aberration, and the prophets not only employed it, but, as in the case of Elisha, appear to have found its use essential. Their music-schools, the arrangements for the Temple-worship, the various styles of composition adapted to different social occasions, prove the time and thought spent in the practice of music to have been, at least from our point of view, excessive; yet in no passages is long-continued indulgence in its exercise censured or moderation advised. The high estimation in which this art was held in times long past and our difficulty in understanding the matter find an illustration in the meeting of Saul with the company of prophets descending a hill, each playing upon a musical instrument. It would seem exceedingly strange to us if a king or president should meet and join a body of learned men in a similar manner.

The technical study of Oriental systems of music is rendered difficult from the fact that these are overlaid with a mass of symbolism, that makes accurate, positive definition frequently unattainable.

In some cases strange and extravagant hyperbole leads to a general notion being formed of the character of certain forms, but yet to great uncertainty as to their actual nature. In the case of some Oriental nations, the perfected systems, the theories and their symbolical analogies and illustrations came to be valued more highly than the music based upon them. The Chinese, for instance, compared at a very early period the twelve notes of the chromatic scale with the lunar zodiac, and the expression of each note with the expression of outward nature—the weather of each month.

Their various modes have characteristic significations. That of Koung (= fa) represents the emperor—the sublimity of his doctrine, the majesty of his countenance, and the high importance of his actions; the mode Cheng (= sol) represents the minister—his intrepidity in the exercise of his duties, firm administration of justice, and slight rigorousness; and so on, throughout the complete series.

The Hindoos were also led to personify all their modes, but their excited, unbridled imaginations led them to place in their heaven the presiding deity of each. Their systems are complicated, symbolical, mystical, and beautiful. They believed in miracle-working melodies, called Ragas, each having its own special power on rain, harvests, sun, wild beasts, etc., and the faith in their efficacy still exists. It is rarely tested because of the alleged difficulty in finding an executive artist competent to perform the music with the proper expression in the particular locality selected for the trial.

The Persians, who regarded music as physic for the soul, found in a tree and its roots and branches a fitting emblem and convenient illustration for their technical system of modes, and, in the strings of their lute, correspondences with their seasons.

The Chaldeans and Egyptians required the whole cosmos for an exemplification of their systems; and thus, through the Greeks, the expression "music of the spheres" has come down to us.

Here, at least, we find a link connecting the dead past with the living present. Pythagoras and the mathematical musicians of his age and country made the middle string of the Greek lyre typify the sun, and the others the planets; and even their opponents, Aristotle and the practical musicians, were led to acknowledge that, when this middle string was out of tune, the whole instrument was out of tune, but that if any other string were untuned the lyre would still be playable. Here evidence is found that there then existed a vague, glimmering notion of the peculiar and inherent importance of some one note, which we now fully recognize, and commonly speak of as the key-note—from which all the other notes are measured, and in which all find justification.

And, further, the Greek modes, Dorian, Phrygian, Lydian, etc., which were somewhat similar to the ecclesiastical modes that bear the same names interchanged, have given place in Europe to our modern

major and minor scales, which are exclusively used by all those peoples who do not employ the Hungarian system. Now, although these scales have hardly been in general use for two centuries, there is gradually growing up among ourselves a recognized scheme of characterization or symbolism analogous to the schemes formulated by the Orientals. For we not only speak of major modes as bright and genial, and minor modes as sorrowful and depressed, irrespective of the music to be cast in these modes—and also regard our sharp keys as brilliant, and flat keys as calm and soothing, irrespective also of the music to be rendered in them, and although we are perfectly certain of the fact that mathematically they present no variation—but we notice that the notes in any one key have each their special signification.

Attempts have been made to define these characteristics, which must be allowed to be successful, for thousands of persons are unanimous that their experiences agree.

The most satisfactory proof of this is that large choral bodies have been trained to sing from printed copies of music, at first sight, most elaborate compositions, simply by being taught to identify the various notes by recognizing uniformly their character, and thus to sing them correctly without the aid of an instrument. The societies acquainted with this—the tonic sol-fa system, in which particular ideas are associated with each note—have for twenty years competed successfully for prizes, at large festivals in England, with the best organizations trained in other methods.

We are, therefore, rapidly forming complex psychologic systems, side by side with our technical systems, which to the ancients would prove as strange and unaccountable as some of theirs do to us; or even still more strange, for the want of sympathy would not be entirely due to difference of musical temperament of scales, or to mere remoteness of period and nation, but to the use of harmony and simultaneous melodies that render our music bewilderingly complex in its structure to those nations who do not employ polyphony.

An elaborate characterization of even one isolated interval—say of the sweet-sighing-sadness of the sixth sound of the Æolian harp, the dominant seventh of nature—could be no more intelligible to one who had never experienced the combination than the sweetness of honey be made known to one who had never tasted it.

Here one would willingly address thoughtful musicians, who strive to understand the present condition of their art, by tracing the history of its phases, being able to appeal to their technical knowledge of our own formal systems of scales, etc., in giving details of other and more complex systems, which can not be made readily comprehensible to the general public. But we must be content to pass on and speak of other links, connecting the present with the most remote ages.

No more ready proof of the great musical acquirements of the ancients can be found than in the marvelous skill shown in their instru-

ments. Many have become obsolete, but others are still in constant use, and are found with various modifications in all countries. They give evidence of high civilization at a very early period, not only in the costliness and rarity of the materials used, and the knowledge of the science of acoustics displayed in their production, but in the mental power required for their first conception.

The hollow-cone-shaped porcelain vases of China, that have five holes to be stopped so that the air within may be made to vibrate in certain determinate ways to produce with accuracy the notes required by the performer, are, as wind-instruments, marvels of inventive genius. The pipes of a Chinese organ are rendered dumb by a hole bored near the foot of each one, and which the player stops with his finger when the pipe is required to sound its note. Acousticians fail to comprehend this; and, although enormously large church-organs are built by ourselves, we do not really know the motion of the vibrating column of air in any one pipe, the wind with which it is supplied not entering it. Nor can we tell why one stopped with a plug at the top, when sounded, vibrates violently on two of its sides, the other two remaining quiescent. Various other phenomena, that are said to be fully understood in recent works on sound, are only partially accounted for.

There is a tendency to refer all instruments to respective epochs, according to their degrees of development, partly because our pianoforte has been so rapidly elaborated from the Irish harp, which alone had a tension-bar, and our harmonium from the Chinese reed, also by the key-board appliance, and partly because consistent theories are so easily invented. We should, therefore, be on our guard in this matter, as in others, respecting chronological sequences, and remember that many instruments have been periodically simplified, as in the case of the violin; or chosen for their simplicity, as in the case of the Greek lyre over that of the Egyptian harp, notwithstanding its extremely limited powers; and particularly the historic fact that most elaborate instruments were known in mythologic times in China.

Adopting the classification of Jubal—the sixth from Adam—"harp and organ" (commonly called "string and wind"), and adding the generally unrecorded percussive instruments to form the third genus, it is not difficult to invent a theory of development. For we may assume that the warrior's bow-string, giving a well-defined tone when pulled with the finger, led to two or more strings being systematized and plucked with the plectrum or struck with mallets, giving rise to the many forms of Egyptian harps, all of which are in the form of a bow, and have no "tension-bar" to resist the pull of the strings; then that the friction of two bows led to the violin species, by the addition and augmentation of resonating cavities for one bow and the modification of the other bow, which has only recently been made, and the addition of a finger-board.

Hand-clapping, not for applause, but rhythmic accentuation as practiced in the East, may be supposed to have led to the Jew's-harp and instruments consisting of bars free at one end, then to others free at both ends, then to plates free all round, as cymbals more or less concave, and subsequently to bells, sonorous boxes, drums, etc.

A simple reed or pipe may be supposed to have led to many pipes being systematized, their materials changed, their mouth-pieces varied, as whistle, beak, single reed, etc.; then that the powers of each pipe were increased by the boring of holes in it at certain particular points, much as a Gray's telephone increases the capacity of a single wire by enabling it to transmit in both directions several messages simultaneously ; then, finally, to the systemization of such pipes.

But here, at the end of our series, we find an instrument, the bagpipe, that figures in Chinese myths. However little we may relish the quality of the tone of this instrument, when it is badly played, and at only a short distance from us, we must give it the highest place in the scheme, and admire the skill displayed in its formation.

The real worth of Oriental music is not to be learned from routine practical musicians, who rarely know anything of the underlying principles of their art, but must be gained by a patient study of ancient writings, in which the respective theories are recorded. For the most part, the theories point to the possession or the possibility of greater art-works than any with which we have become acquainted ; and the cultivation of certain departments of the art, which we neglect.

The Chinese are sensitive to changes of pitch (transposition), to the exact agreement of the words of a song and its music, as well as to the expression imparted to their ordinary speech by vocal inflections ; while we are for the most part indifferent as to absolute pitch, set poetic rhythms to dance-tunes, have different verses to the same music, and less frequently speak with strongly marked variations of tone. Their belief that not only the voice of man, but all nature, should praise its Creator, led them to make an elaborate system of quality of tone (*timbre*), selecting eight kinds of materials from the animal, vegetable, and mineral kingdoms for the construction of musical instruments.

But, although they spent much labor in devising complete schemes, formulating scales, and calculating them with great nicety (like the modern Persians), even to the invention of the "equal temperament" (which European nations subsequently learned to use), in devising a regular notation, and in fact securing all the appliances necessary for the production of really great music, we fail to find them in possession of a single melody that would be generally acceptable to a modern audience. Their composers appear to be deficient in the power of imagination, without which it is impossible to invent a beautiful musical idea. We regard our melodies as so many happy thoughts, or felicitous expressions, developed with consistency and true to some particu-

lar mental mood ; or at least presenting some recognizable sequential psychologic progression. Yet nevertheless, they have compositions intended to describe scenes, as if music to them conveyed definite intelligible ideas. Thus, one composition (although to us almost ludicrous from its awkwardness, shortness, and want of coherence) appears to have simulated for them the progress of a battle, being marked at various points, "The proclamation of the general," "His warriors preparing their fighting-men," "The general gives his orders," etc., ending with "Repose after victory."

The absence of harmony not only makes all these specimens unattractive, but the fact that they were conceived entirely free from the influence of harmonic design renders them foreign to our thoughts. We may whistle or hum a Strauss waltz or little Verdi tune with satisfaction, because these melodies were produced under the bias or dominion of harmonies, which are generally so simple and natural that we commonly say that they are implied in the melodic shape. For this reason an accompaniment may be extemporized or imagined. And the modern system of chords tending to create a desire for a constant return to the key-note, whenever a satisfactory termination is required, the absence of this acknowledged sound in Chinese melodies seems to make a cadence, in our sense of the word, impossible to them.

The Chinese language being monosyllabic, it lends itself readily to the Canto-Fermo style of song that is employed in ancestral worship, and which greatly resembles the style of the old Lutheran chorals, except that the melody of the former makes more skips upward and downward.

The lines of the poetry being four syllables in length in every strophe (as "See hoang sien tsow" of the "Ancestral Hymn"), and the notes being long and of equal length, a rhythmic uniformity is secured. But this is merely accidental, for in the secular melodies no evidence of a symmetrical rhythmic order or plan is observable, which also makes a definite rhythmic termination on a strong and anticipated accent as impossible as the definite tonal termination already noticed. The Chinese do not even appear to understand stress or accent, for in the orchestral score of the above hymn the instruments of percussion mark off groups of notes, not by greater stress, but by an increased number of instruments.

Turning to their neighbors, the Hindoos, on the contrary, we find extremely elaborate rhythmic designs (musical feet), and also phrases so symmetrical and compact that they are at once acceptable, and so coherent and consistent in their succession as to suggest words indicative of well-known moods. In this respect they present no difficulties, and are more easily supplied with accompaniments than those of the Chinese.

Our immediate acceptance of Indian music attests our Aryan fellowship.

The use of silk for strings and the employment of instruments of extreme softness in the East, sufficiently disprove the statement that ancient music was barbaric and noisy. Many instruments of percussion are soft as drops of water falling into a fountain. Chaldean music was soft and sentimental. Egyptian harps were not of powerful tone. The Hindoos have a flute with vibratory apparatus so extremely delicate that it is sounded by one end being suddenly pressed to the neck of the performer. The Greeks and Persians loved soft music, and singers did not strain their voices. The Hebrews alone among ancient people sang "with all their might" unrestrainedly, and delighted in making a grand consensus of tone in their choruses of voices and instruments and the clapping of hands. In other nations solo performances were more general, and among the Hindoos an executant would risk his reputation if he did not execute variations on a theme at each recurrence. These and other performances were most frequently extemporaneous. Conception and realization being thus conjoined, the result of sudden impulse, it was necessary for the player to warm with his theme until he became intensely interested in it; and his excited imagination to be stimulated by other influences until he succeeded in his artistic efforts, and in gratifying his audience. No cold reflection supervened, the composer was his own performer, his enthusiasm was perceived and his improvisations at every turn were surprises that gave delight.

A complete history of music would be a history of the world, so intimately is it found connected with the language, habits, poetry, religion, and life of the various nations. Our form of the art is alone adapted to our wants; and when we consider its enhanced powers, its modern counterpoint and harmony, we are at a loss to understand how Oriental music, with its greater limitations, could exercise so powerful a sway over its hearers.

Oriental music has, for ages, shed a benignant and salutary influance on the hearts, minds, and senses of millions of persons, and still is a source of gratification to more than half the population of the globe. It has given immediate expression to many various conditions of mind, has raised noble feelings and subdued painful ones; it has alleviated suffering and softened down coarseness and hardness of heart.

The joys and sorrows, aspirations and emotions of an age are sounded forth in its music; therefore that of the past is chiefly valuable as a contribution to historic national psychology. Let us so live that our own music, as a reflex image of ourselves, may attest our progress, not only in the physical sciences, but in nobleness of soul and all true worthiness.

THE SABBATH.*

By Professor JOHN TYNDALL, F.R.S.

I.

IN the opening words of a lecture delivered in this city four years ago, I spoke of the desire and tendency of the present age to connect itself organically with preceding ages. The expression of this desire is not limited to the connection of the material organisms of to-day with those of the geologic past. It is equally manifested in the domain of mind. To this source, for example, may be traced the philosophical writings of Mr. Herbert Spencer. To it we are indebted for the series of learned works on "The Sources of Christianity," by M. Renan. To it we owe the researches of Professor Max Müller in comparative philology and mythology, and the endeavor to found on these researches a "science of religion." In this relation, moreover, the recent work of Principal Caird † is highly characteristic of the tendencies of the age. He has no words of vituperation for the older phases of faith. Throughout the ages he discerns a purpose and a growth, wherein the earlier and more imperfect religions constitute the natural and necessary precursors of the later and more perfect ones. Even in the slough of ancient paganism, Principal Caird detects a power ever tending toward amelioration, ever working toward the advent of a better state, and finally emerging in the purer life of Christianity. ‡

These changes in religious conceptions and practices correspond to the changes wrought by augmented experience in the texture and contents of the human mind. Acquainted as we now are with this immeasurable universe, and with the energies operant therein, the guises under which the sages of old presented the Maker and Builder thereof seem to us to belong to the utter infancy of things. To point to illustrations drawn from the heathen world would be superfluous. We may mount higher, and still find our assertion true. When, for example, Moses and Aaron, Nadab and Abihu, and seventy elders of Israel are represented as climbing Mount Sinai, and actually seeing there the God of Israel, we listen to language to which we can attach no significance. "There is in all this," says Principal Caird, "much which, even when religious feeling is absorbing the latent nutriment contained in it, is perceived [by the philosophic Christian of to-day] to belong to the domain of materialistic and figurative conception." The

* Presidential address to the Glasgow Sunday Society, delivered in St. Andrew's Hall, October 25, 1880.

† "Introduction to the Philosophy of Religion."

‡ In Professor Max Müller's "Introduction to the Science of Religion" some excellent passages occur, embodying the above view of the continuity of religious development.

children of Israel received without idealization the statements of their great law-giver. To them the tables of the law were true tablets of stone, prepared, engraved, broken, and reëngraved; while the graving-tool which inscribed the law was held undoubtingly to be the finger of God. To us such conceptions are impossible. We may by habit use the words, but we attach to them no definite meaning. "As the religious education of the world advances," says Principal Caird, "it becomes impossible to attach any literal meaning to those representations of God and his relations to mankind which ascribe to him human senses, appetites, passions, and the actions and experiences proper to man's lower and finite nature."

Principal Caird, nevertheless, ascribes to this imaging of the Unseen a special value and significance, regarding it as furnishing an objective counterpart to religious emotion, permanent but plastic—capable of indefinite change and purification in response to the changing moods and aspirations of mankind. It is solely on this mutable element that he fixes his attention in estimating the religious character of individuals or nations. "Here," he says, "the fundamental inquiry is as to the objective character of their religious ideas or beliefs. The first question is, not how they feel, but what they think and believe; not whether their religion manifests itself in emotions more or less vehement or enthusiastic, but what are the conceptions of God and divine things by which these emotions are called forth?" These conceptions "of God and divine things" were, it is admitted, once "materialistic and figurative," and therefore objectively untrue. Nor is their purer essence yet distilled; for the religious education of the world still "advances," and is, therefore, incomplete. Hence the essentially fluxional character of that objective counterpart to religious emotion to which Principal Caird attaches most importance. He, moreover, assumes that the emotion is called forth by the conception. We have doubtless action and reaction here; but it may be questioned whether the conception, which is a construction of the human understanding, could be at all put together without materials drawn from the experience of the human heart.*

The changes of conception here adverted to have not always been peacefully brought about. The "transmutation" of the old beliefs was often accompanied by conflict and suffering. It was conspicuously so during the passage from paganism to Christianity. In his work entitled "L'Église Chrétienne," Renan describes the sufferings of a group of Christians at Smyrna which may be taken as typical. The victims were cut up by the lash till the inner tissues of their bodies

* While reading the volume of Principal Caird I was reminded more than once of the following passage in Renan's "Antéchrist": "Et d'ailleurs, quel est l'homme vraiment religieux qui répudie complètement l'enseignement traditionnel à l'ombre duquel il sentit d'abord l'idéal, qui ne cherche pas les conciliations, souvent impossibles, entre sa vieille foi et celle à laquelle il est arrivé par le progrès de sa pensée?"

were laid bare. They were dragged naked over pointed shells. They were torn by lions; and finally, while still alive, were committed to the flames. But all these tortures failed to extort from them a murmur or a cry. The fortitude of the early Christians gained many converts to their cause; still, when the evidential value of fortitude is considered, it must not be forgotten that almost every faith can point to its rejoicing martyrs. Even these Smyrna murderers had a faith of their own, the imperiling of which by Christianity spurred them on to murder. From faith they extracted the diabolical energy which animated them. The strength of faith is, therefore, no proof of the objective truth of faith. Indeed, at the very time here referred to we find two classes of Christians equally strong—Jewish Christians and Gentile Christians—who, while dying for the same Master, turned their backs upon each other, mutually declining all fellowship and communion.

Thus early the forces which had differentiated Christianity from paganism made themselves manifest in details, producing disunion among those whose creeds and interests were in great part identical. Struggles for priority were not uncommon. Jesus himself had to quell such contentions. His exhortations to humility were frequent. "He that is least among you shall be greatest of all." There were also conflicts upon points of doctrine. The difference which concerns us most had reference to the binding power of the Jewish law. Here dissensions broke out among the apostles themselves. Nobody who reads with due attention the epistles of Paul can fail to see that this mighty propagandist had to carry on a life-long struggle to maintain his authority as a preacher of Christ. There were not wanting those who denied him all vocation. James was the head of the Church at Jerusalem, and Judeo-Christians held that the ordination of James was alone valid. Paul, therefore, having no mission from James, was deemed by some a criminal intruder. The real fault of Paul was his love of freedom, and his uncompromising rejection, on behalf of his Gentile converts, of the chains of Judaism. He proudly calls himself "the Apostle of the Gentiles." He says to the Corinthians: "I suppose I was not a whit behind the very chiefest apostles. Are they Hebrews? So am I. Are they Israelites? So am I. Are they of the seed of Abraham? So am I. Are they ministers of Christ? I am more; in labors more abundant, in stripes above measure, in deaths oft." He then establishes his right to the position which he claimed, by recounting in detail the sufferings he had endured. I leave it to you to compare this Christian hero with some of the "freethinkers" of our own day, who flaunt in public their cheap and trumpery theories of the great Apostle and the Master whom he served.

Paul was too outspoken to escape assault. All insincerity and double-facedness—all humbug, in short—were hateful to him; and even among his colleagues he found scope for this feeling. Judged by

our standard of manliness, Peter, in moral stature, fell far short of Paul. In that supreme moment when his Master required of him "the durance of a granite ledge" Peter proved "unstable as water." He ate with the Gentiles when no Judeo-Christian was present to observe him; but when such appeared he withdrew himself, fearing those which were of the circumcision. Paul charged him openly with dissimulation. But Paul's quarrel with Peter was more than personal. Paul contended for a principle, determined to shield his Gentile children in the Lord from the yoke which their Jewish co-religionists would have imposed upon them. "If thou," he says to Peter, "being a Jew, livest after the manner of the Gentiles, and not as do the Jews, why compellest thou the Gentiles to live as the Jews?" In the spirit of a true liberal he overthrew the Judaic preferences for days, deferring at the same time to the claims of conscience. "Let him who desires a Sabbath," he virtually says, "enjoy it; but let him not impose it on his brother who does not." The rift thus revealed in the apostolic lute widened with time, and Christian love was not the feeling which long animated the respective followers of Peter and Paul.

We who have been born into a settled state of things can hardly realize the primitive commotions out of which this tranquillity has emerged. We have, for example, the canon of Scripture already arranged for us. But to sift and select these writings from the mass of spurious documents afloat at the time of compilation was a work of vast labor, difficulty, and responsibility. The age was rife with forgeries. Even good men lent themselves to these pious frauds, believing that true Christian doctrine, which of course was *their* doctrine, would be thereby quickened and promoted. There were gospels and counter-gospels; epistles and counter-epistles—some frivolous, some dull, some speculative and romantic, and some so rich and penetrating, so saturated with the Master's spirit, that, though not included in the canon, they enjoyed an authority almost equal to that of the canonical books. The end being held to sanctify the means, there was no lack of manufactured testimony. The Christian world seethed not only with apocryphal writings, but with hostile interpretations of writings not apocryphal. Then arose the sect of the Gnostics—men who *know*—who laid claim to the possession of a perfect science, and who, if they were to be believed, had discovered the true formula for what philosophers called "the absolute." But these speculative Gnostics were rejected by the conservative and orthodox Christians of their day as fiercely as their successors the Agnostics—men who *don't know*—are rejected by the orthodox in our own. The martyr Polycarp one day met Marcion, an ultra-Paulite, and a celebrated member of the Gnostic sect. On being asked by Marcion whether he, Polycarp, did not know him, Polycarp replied, "Yes, I know you very well; you are the first-born of the devil."* This is a sample of the

* "L'Église Chrétienne," p. 450.

bitterness then common. It was a time of travail—of throes and whirlwinds. Men at length began to yearn for peace and unity, and out of the embroilment was slowly consolidated that great organization, the Church of Rome. The Church of Rome had its precursor in the Church *at* Rome. But Rome was then the capital of the world; and, in the end, that great city gave the Christian Church established in her midst such a decided preponderance that it eventually laid claim to the proud title of "Mother and Matrix of all other Churches."

With jolts and oscillations, resulting at times in overthrow, the religious life of the world has spun down the "the ringing grooves of change." A smoother route may have been undiscoverable. At all events, it was undiscovered. Many years ago I found myself in discussion with a friend who entertained the notion that the general tendency of things in this world is toward an equilibrium of peace and blessedness to the human race. My notion was, that equilibrium meant not peace and blessedness, but death. No motive power is to be got from heat, save during its *fall* from a higher to a lower temperature, as no power is to be got from water save during its descent from a higher to a lower level. Thus also life consists, not in equilibrium but in the passage toward equilibrium. In man it is the leap from the potential, through the actual, to repose. The passage often involves a fight. Every natural growth is more or less of a struggle with other growths, in which, in the long run, the fittest survives. Some are, and must be, wiser than the rest; and the enunciation of a thought in advance of the moment provokes dissent and thus promotes action. The thought may be unwise; but it is only by discussion, checked by experience, that its value can be determined. Discussion, therefore, is one of the motive powers of life, and, as such, is not to be deprecated. Still one can hardly look without despair on the passions excited and the energies wasted over questions which, after ages of strife, are shown to be mere foolishness. Thus the theses which shook the world during the first centuries of the Christian era have, for the most part, shrunk into nothingness. It may, however, be that the human mind could not become fitted to pronounce judgment on a controversy otherwise than by wading through it. We get clear of the jungle by traversing it. Thus even the errors, conflicts, and sufferings of bygone times may have been necessary factors in the education of the world. Let nobody, however, say that it has not been a hard education. The yoke of religion has not always been easy, nor its burden light—a result arising, in part, from the ignorance of the world at large, but more especially from the mistakes of those who had the charge and guidance of a great spiritual force, and who guided it blindly. Looking over the literature of the Sabbath question, as catalogued and illustrated in the laborious, able, and temperate work of the late Mr. Robert Cox, we can hardly repress a sigh in thinking of the gifts and labors of intellect which this question has

absorbed, and the amount of bad blood it has generated. Further reflection, however, reconciles us to the fact that waste in intellect may be as much an incident of growth as waste in nature.

When the various passages of the Pentateuch which relate to the observance of the Sabbath are brought together, as they are in the excellent work of Mr. Cox, and when we pass from them to the similarly collected utterances of the New Testament, we are immediately exhilarated by a freer atmosphere and a vaster sky. Christ found the religions of the world oppressed almost to suffocation by the load of formulas piled upon them by the priesthood. He removed the load, and rendered respiration free. He cared little for forms and ceremonies, which had ceased to be the raiment of man's spiritual life. To that life he looked, and it he sought to restore. It was remarked by Martin Luther that Jesus broke the Sabbath deliberately, and even ostentatiously, for a purpose. He walked in the fields; he plucked, shelled, and ate the corn; he treated the sick, and his spirit may be detected in the alleged imposition upon the restored cripple of the labor of carrying his bed on the Sabbath-day. He crowned his protest against a sterile formalism by the enunciation of a principle which applies to us to-day as much as to the world in the time of Christ: "The Sabbath was made for man, and not man for the Sabbath."

Though the Jews, to their detriment, kept themselves as a nation intellectually isolated, the minds of individuals were frequently colored by Greek thought and culture. The learned and celebrated Philo, who was contemporary with Josephus, was thus influenced. Philo expanded the uses of the seventh day by including in its proper observance studies which might be called secular. "Moreover," he says, "the seventh day is also an example from which you may learn the propriety of studying philosophy. As on that day it is said God beheld the works that he had made, so you also may yourself contemplate the works of Nature." Permission to do this is exactly what the members of the Sunday Society humbly claim. The Jew, Philo, would grant them this permission, but our straiter Christians will not. Where shall we find such samples of those works of Nature which Philo commended to the Sunday contemplation of his countrymen as in the British Museum? Within those walls we have, as it were, epochs disentombed—ages of divine energy illustrated. But the efficient authorities—among whom I would include a short-sighted portion of the public—resolutely close the doors, and exclude from the contemplation of these things the multitudes who have only Sunday to devote to them. Taking them on their own ground, we ask, are the authorities lógical in doing so? Do they who thus stand between them and us really believe those treasures to be the work of God? Do they or do they not hold, with Paul, that "the eternal power and Godhead" may be clearly seen from "the things that are made"? If they do—and they dare not affirm

that they do not—I fear that Paul, in his customary language, would pronounce their conduct to be "without excuse." *

Science, which is the logic of nature, demands proportion between the house and its foundation. Theology sometimes builds weighty structures on a doubtful base. The tenet of Sabbath observance is an illustration. With regard to the time when the obligation to keep the Sabbath was imposed, and the reasons for its imposition, there are grave differences of opinion between learned and pious men. Some affirm that it was instituted at the Creation in remembrance of the rest of God. Others allege that it was imposed after the departure of the Israelites from Egypt, and in memory of that departure. The Bible countenances both interpretations. In Exodus we find the origin of the Sabbath described with unmistakable clearness, thus: "For in six days the Lord made heaven and earth, the sea, and all that in them is, and rested the seventh day. *Wherefore* the Lord blessed the seventh day, and hallowed it." In Deuteronomy this reason is suppressed and another is assigned. Israel being a servant in Egypt, God, it is stated, brought them out of it through a mighty hand and by a stretched-out arm. "*Therefore* the Lord thy God commanded thee to keep the Sabbath-day." After repeating the ten commandments, and assigning the foregoing origin to the Sabbath, the writer in Deuteronomy proceeds thus: "These words the Lord spake unto all your assembly in the mount, out of the midst of the fire, of the cloud, and the thick darkness, with a loud voice; and he added no more." But in Exodus God not only added more, but something entirely different. This has been a difficulty with commentators—not formidable, if the Bible be treated as any other ancient book, but extremely formidable on the theory of plenary inspiration. I remember in the days of my youth being shocked and perplexed by an admission made by Bishop Watson in his celebrated "Apology for the Bible," written in answer to Tom Paine. "You have," says the Bishop, "disclosed a few weeds which good men would have covered up from view." That there were "weeds" in the Bible requiring to be kept out of sight was to me, at that time, a new revelation. I take little pleasure in dwelling upon the errors and blemishes of a book rendered venerable to me by intrinsic wisdom and imperishable associations. But when that book is wrested to our detriment, when its passages are invoked to justify the imposition of a yoke, irksome because unnatural, we are driven in self-defense to be critical. In self-defense, therefore, we plead these two discordant accounts of the origin of the Sabbath, one of which makes it a purely Jewish institution, while the other, unless regarded as a mere myth and figure, is in violent antagonism to the facts of geology.

With regard to the alleged "proofs" that Sunday was introduced

* I refer, of course, to those who object to the opening of the museums on religious grounds. The administrative difficulty stands on a different footing. But surely *it* ought to vanish in presence of the public benefits which in all probability would accrue.

as a substitute for Saturday, and that its observance is as binding upon Christians as their Sabbath was upon the Jews, I can only say that those which I have seen are of the flimsiest and vaguest character. "If," says Milton, "on the plea of a divine command, they impose upon us the observances of a particular day, how do they presume, without the authority of a divine command, to substitute another day in its place?" Outside the bounds of theology no one would think of applying the term "proofs" to the evidence adduced for the change; and yet on this pivot, it has been alleged, turns the eternal fate of human souls.* Were such a doctrine not actual it would be incredible. It has been truly said that the man who accepts it sinks, in doing so, to the lowest depth of atheism. It is perfectly reasonable for a religious community to set apart one day in seven for rest and devotion. Most of those who object to the Judaic observance of the Sabbath recognize not only the wisdom but the necessity of some such institution, not on the ground of a divine edict, but of common sense.† They contend, however, that it ought to be as far as possible a day of cheerful renovation both of body and spirit, and not a day of penal gloom. There is nothing that I should withstand more strenuously than the conversion of the first day of the week into a common working day. Quite as strenuously, however, should I oppose its being employed as a day for the exercise of sacerdotal rigor.

The early reformers emphatically asserted the freedom of Christians from Sabbatical bonds; indeed, Puritan writers have reproached them with dimness of vision regarding the observance of the Lord's day. "The fourth commandment," says Luther, "literally understood, does not apply to us Christians; for it is entirely outward, like other ordinances of the Old Testament, all of which are now left free by Christ. If a preacher," he continues, "wishes to force you back to Moses, ask him whether you were brought by Moses out of Egypt? If he says no, then say, How, then, does Moses concern me, since he speaks to the people that have been brought out of Egypt? In the New Testament Moses comes to an end, and his laws lose their force. He must bow in the presence of Christ." "The Scripture," says Melanchthon, "allows that we are not bound to keep the Sabbath; for it teaches that the ceremonies of the law of Moses are not neces-

* In 1785 the first mail-coach reached Edinburgh from London, and in 1788 it was continued to Glasgow. The innovation was denounced by a minister of the Secession Church of Scotland as "contrary to the laws both of Church and state; contrary to the laws of God; contrary to the most conclusive and constraining reasons assigned by God; and calculated not only to promote the hurt and ruin of the nation, but also the eternal damnation of multitudes."—(Cox, vol. ii, p. 248.) Even in our own day there are clergymen foolish enough to indulge in this dealing out of damnation.

† "That public worship," says Milton, "is commended and inculcated as a voluntary duty, even under the Gospel, I allow; but that it is a matter of compulsory enactment, binding on believers from the authority of this commandment, or of any Sinaitical precept whatever, I deny."

sary after the revelation of the Gospel. And yet," he adds, "because it was requisite to appoint a certain day that the people might know when to assemble together, it appeared that the Church appointed for this purpose the Lord's day." I am glad to find my grand old namesake on the side of freedom in this matter. "As for the Sabbath," says the martyr Tyndale, "we are lords over it, and may yet change it into Monday, or into any other day, as we see need; or may make every tenth day holy day, only if we see cause why. Neither need we any holy day at all if the people might be taught without it." Calvin repudiated "the frivolities of false prophets who, in later times, have instilled Jewish ideas into the people. Those," he continues, "who thus adhere to the Jewish institution go thrice as far as the Jews themselves in the gross and carnal superstition of Sabbatism." Even John Knox, who has had so much Puritan strictness unjustly laid to his charge, knew how to fulfill on the Lord's day the duties of a generous, hospitable host. His Master feasted on the Sabbath-day, and he did not fear to do the same on Sunday.

Toward the end of the sixteenth century, demands for a stricter observance of the Sabbath began to be made—probably in the first instance with some reason, and certainly with good intent. The manners of the time were coarse, and Sunday was often chosen for their offensive exhibition. But, if there was coarseness on the one side, there was ignorance both of nature and human nature on the other. Contemporaneously with the demands for stricter Sabbath rules, God's judgments on Sabbath-breakers began to be pointed out. Then and afterward "God's judgments" were much in vogue, and man, their interpreter, frequently behaved as a fiend in the supposed execution of them. But of this subsequently. A Suffolk clergyman named Bownd, who, according to Cox, was the first to set forth at large the views afterward embodied in the Westminster Confession, adduces many such judgments. One was the case of a nobleman "who for hunting on the holy day was punished by having a child with a head like a dog's." Though he cites this instance, Bownd, in the matter of Sabbath observance, was very lenient toward noblemen. With courtier-like pliancy, which is not without its counterpart at the present time, he makes an exception in their favor: "Concerning the feasts of noblemen and great personages or their ordinary diet upon this day, because they represent in some measure the majesty of God on the earth, in carrying the image, as it were, of the magnificence and puissance of the Lord, much is to be granted to them."

Imagination once started in this direction was sure to be prolific. Instances accordingly grew apace in number and magnitude. Memorable examples of God's judgments upon Sabbath-breakers, and other like libertines, in their unlawful sports happening within this realm of England, were collected. Innumerable cases of drowning while bathing on Sunday were adduced, without the slightest attention to the

logical requirements of the question. Week-day drownings were not dwelt upon, and nobody knew or cared how the question of proportion stood between the two classes of bathers. The civil war was regarded as a punishment for Sunday desecration. The fire of London and a subsequent great fire in Edinburgh were ascribed to this cause; while the fishermen of Berwick lost their trade through catching salmon on Sunday. A Nonconformist minister named John Wells, whose huge volume is described by Cox as "the most tedious of all the Puritan productions about the Sabbath," is specially copious in illustration. A drunken peddler, "fraught with commodities" on Sunday, drops into a river: God's retributive justice is seen in the fact. Wells traveled far in search of instances. One Utrich Schrœtorus, a Swiss, while playing at dice on the Lord's day, lost heavily, and apparently to gain the devil to his side broke out into this horrid blasphemy: "If fortune deceive me now I will thrust my dagger into the body of God." Whereupon he threw the dagger upward. It disappeared, and five drops of blood, which afterward proved indelible, fell upon the gaming-table. The devil then appeared, and with a hideous noise carried off the vile blasphemer. His two companions fared no better. One was struck dead and turned into worms, the other was executed. A vintner who on the Lord's day tempted the passers-by with a pot of wine was carried into the air by a whirlwind and never seen more. "Let us read and tremble," adds Mr. Wells. At Tidworth a man broke his leg on Sunday while playing at football. By a secret judgment of the Lord the wound turned into a gangrene, and in pain and terror the criminal gave up the ghost.

You may smile at these recitals, but is there not a survival of John Wells still extant among us? Are there not people in our midst so well informed regarding "the secret judgments of the Lord" as to be able to tell you their exact value and import, from the damaging of the share-market through the running of Sunday trains to the calamitous overthrow of a railway bridge? Alphonso of Castile boasted that, if he had been consulted at the beginning of things, he could have saved the Creator some worlds of trouble. It would not be difficult to give the God of our more rigid Sabbatarians a lesson in justice and mercy; for his alleged judgments savor but little of either. How are calamities to be classified? Almost within ear-shot of those who note these Sunday judgments, the poor miners of Blantyre are blown to pieces, while engaged in their sinless week-day toil. A little farther off the bodies of two hundred and sixty workers, equally innocent of Sabbath-breaking, are entombed at Abercarne. Dinas holds its sixty bodies, while the present year has furnished its fearful tale of similar disasters. Whence comes the vision which differentiates the Sunday calamity from the week-day calamity, seeing in the one a judgment of Heaven, and in the other a natural event? We may wink at the ignorance of John Wells, for he lived in a pre-scientific

age ; but it is not pleasant to see his features reproduced, on however small a scale, before an educated nation in the latter half of the nineteenth century.

Notwithstanding their strictness about the Sabbath, which possibly carried with it the usual excess of a reaction, some of the straitest of the Puritan sect saw clearly that unremitting attention to business, whether religious or secular, was unhealthy. Considering recreation to be as necessary to health as daily food, they exhorted parents and masters, if they would avoid the desecration of the Sabbath, to allow to children and servants time for honest recreation on other days. They might have done well to inquire whether even Sunday devotions might not, without "moral culpability" on their part, keep the minds of children and servants too long upon the stretch. I fear many of the good men who insist on a Judaic observance of the Sabbath, and who dwell upon the peace and blessedness to be derived from a proper use of the Lord's day, generalize beyond their data, applying the experience of the individual to the case of mankind. What is a conscious joy and blessing to themselves they can not dream of as being a possible misery, or even a curse, to others. It is right that your most spiritually-minded men—men who, to use a devotional phrase, enjoy the closest walk with God—should be your pastors. But they ought also to be practical men, able to look not only on their personal feelings, but on the capacities of humanity at large, and willing to make their rules and teachings square with these capacities. There is in some minds a natural bias toward religion, as there is in others toward poetry, art, or mathematics ; but the poet, artist, or mathematician, who would seek to impose upon others not possessing his tastes the studies which give him delight, would be deemed an intolerable despot. The philosopher Fichte was wont to contrast his mode of rising into the atmosphere of faith with the experience of others. In his case the process, he said, was purely intellectual. Through reason he reached religion ; while in the case of many whom he knew this process was both unnecessary and unused, the bias of their minds sufficing to render faith, without logic, clear and strong. In making rules for the community these natural differences must be taken into account. The yoke which is easy to the few may be intolerable to the many, not only defeating its own immediate purpose, but frequently introducing recklessness or hypocrisy into minds which a franker and more liberal treatment would have kept free from both.*—*Nineteenth Century.*

* "When our Puritan friends," says Mr. Frederick Robertson, "talk of the blessings of the Sabbath, we may ask them to remember some of its curses." Other and more serious evils than those recounted by Mr. Robertson may, I fear, be traced to the system of Sabbath observance pursued in many of our schools. At the risk of shocking some worthy persons, I would say that the invention of an invigorating game for fine Sunday afternoons, and healthy in-door amusement for wet ones, would prove infinitely more effectual as an aid to moral purity than most of our plans of religious meditation.

BIOGRAPHICAL SKETCH OF PROFESSOR DUMAS.

By A. W. HOFMANN.*

THIS able chemist and distinguished man of science, now eighty years of age, and still fulfilling, with almost youthful freshness, the duties of Permanent Secretary to the Academy of Sciences, has been identified with the progress of science in France during half a century, and has gone through an amount of active, diversified labor which has hardly a parallel among his contemporaries.

JEAN-BAPTISTE ANDRÉ DUMAS was born at Alais, in the department of Gard, July 14, 1800. His father was clerk of the municipality, and a cultivated man. He early studied Latin in the college of his native town, and became interested in the classical traditions of his neighborhood, which had many imposing remains of Roman antiquity. But the situation was one calculated to foster an interest also in the objects of nature and the processes of science and art. There were coal-mines, glass-works, brick-yards, tile-works, manufactories of coarse earthenware, lime-kilns, vitriol-factories, and mines of iron, lead, and antimony, all in the immediate region of Alais. The lessons of these industries were not lost upon young Dumas, who, at fourteen years of age, had acquired a rudimentary knowledge of the several natural sciences. At this time he was apprenticed to an apothecary. But there was not much opportunity of scientific study, and this, added to the political and military distraction of the time, inspired him with a strong desire to quit his native town.

In 1816 Dumas accordingly went to Geneva. Here he found scope for study and opportunities to begin a career. He attended the lectures on botany by M. de Candolle, on physics by M. Pictet, and on chemistry by M. Gaspard de la Rive. He had the superintendence of a large pharmaceutical laboratory, which was found deficient in apparatus. But a supply was rapidly improvised. To obtain gas-jars, lamp-chimneys were closed with watch-glasses, cemented on with wax. An old bronze syringe was turned into an air-pump, and barometer-tubes bent over a flame completed the stock of apparatus. Gradually the laboratory improved. As the ambition of the young Professor grew, he began to long for a chemical balance. This wish also was satisfied; with the aid of some workmen in a watch-maker's shop an instrument was constructed which enabled him to begin his analytical researches. He here commenced earnestly the study of chemistry, and began at once the work of research. One of his little discoveries had the following result: When analyzing various sulphates and other salts of commerce, he had observed that the water they contained was

* Condensed from the excellent "Life of Dumas" in "Nature," February 6, 1880.

present in definite equivalents. He had not found this recorded anywhere, and had, therefore, taken great pains to establish the accuracy of his observations. When the investigation was finished, he went one morning early to M. de la Rive, and timidly submitted to him the manuscript embodying the results of his inquiry. While glancing over it, M. de la Rive could not conceal his surprise. When he had come to the end he said to the young student, "Is it you, my boy, who have made these experiments?" "Certainly." "And they have taken you a good deal of time to perform?" "Of course they have." "Then I must tell you that you have had the good fortune to meet Berzelius on the same field of research. He has preceded you, but he is older than you, and so you ought not to bear him ill will on this account." Dumas, not a little embarrassed, was unable to utter a single word. It was, in fact, his first interview with M. de la Rive, whose lectures he had attended, but whom he had never personally accosted. But his perplexity was not to last long. With the utmost good nature M. de la Rive put an end to his gloomy reflections by taking his arm and saying, "Come along and breakfast with me." Before long the conversation had become animated and cheerful. The acquaintance was made, and the kindly feeling of his teacher won by Dumas at this breakfast never subsequently failed him.

This was when Dumas was eighteen years of age. For the next four years he worked with great assiduity in experimental chemistry, and especially, in association with Prévost, upon the problems of organic chemistry, in which they were pioneers.

In 1822 Dumas might have settled at Geneva, and many circumstances led him to think seriously of doing so. An incident, however, which happened at that time, and which at first sight seemed in no way likely to influence a well-matured plan of life, induced him within a few days to change his mind. He made the acquaintance of a man, among whose varied gifts the fascinating sway he exercised over youthful minds was not the least. Let me try to give the story in the very words in which I heard it from Dumas's mouth.

"One day," he said, "when I was in my study completing some drawings at the microscope, and, it must be added, rather negligently attired, in order to enable me to move more freely, some one mounted the stairs, stopped on my landing, and gently knocked at the door. 'Come in,' said I, without looking up from my work. On turning round I was surprised to find myself face to face with a gentleman, in a bright blue coat with metal buttons, a white waistcoat, nankeen breeches, and top-boots. This costume, which might have been the fashion under the Directory, was then quite out of date. The wearer of it, his head somewhat bent, his eyes deep-set but keen, advanced with a pleasant smile, saying, 'Monsieur Dumas?' 'The same, sir; but excuse me.' 'Don't disturb yourself. I am M. de Humboldt, and did not wish to pass through Geneva without having had the pleasure

of seeing you.' Throwing on my coat, I hastily reiterated my apologies. I had only one chair. My visitor was pleased to accept it, while I resumed my elevated perch on the drawing-stool. Baron Humboldt had read the papers published by M. Prévost and myself on blood, which had just appeared in the "Bibliothèque Universelle," and was anxious to see the preparations I had by me. His wish was soon gratified. 'I am going to the Congress at Verona,' said he, 'and I intend to spend some days at Geneva, to see old friends and to make new ones, and more especially to become acquainted with young people who are beginning their career. Will you act as my cicerone? I warn you, however, that my rambles begin early and end late. Now, could you be at my disposal, say, from six in the morning till midnight?' This proposal, which was of course accepted with alacrity, proved to me a source of unexpected pleasure. Baron Humboldt was fond of talking; he passed from one subject to another without stopping. He obviously liked being listened to, and there was no fear of his being interrupted by a young man who for the first time heard Laplace, Berthollet, Gay-Lussac, Arago, Thenard, Cuvier, and many others of the Parisian celebrities, spoken of with familiarity. I listened with a strange delight; a new horizon began to dawn upon me. Save the time devoted to some visits, I was allowed to remain the whole day with Humboldt, who darted from point to point over the vast range of his recollections, while I endeavored to keep pace with the uninterrupted flow of his narrative. Sometimes the mountain scenery would remind him of the Cordilleras, though it must be confessed he did not think much even of Mont Blanc. Sometimes he turned to science, and then astronomy and physics, chemistry, and the natural history branches would, in rapid succession, come in for their share in the dialogue, or rather monologue, which, spoken in a low, somewhat monotonous tone, would have scarcely appeared impressive had it not been for some waggish pleasantry which now and then escaped, as it were, involuntarily. But, at any rate, if his voice failed to be effective, the glance of his eye was sufficient to rivet his hearers' attention.

"At the end of a few days Baron Humboldt left Geneva. After his departure the town seemed empty to me. I felt as if spellbound. The memorable hours I had spent with that irresistible enchanter had opened a new world to my mind. I had been more especially impressed with what he had told me of Parisian life, of the happy collaboration of men of science, and of the unlimited facilities which the French capital offered to young men wishing to devote themselves to scientific pursuits. I began to think that Paris was the only place where, under the auspices of the leaders of physical and chemical science, with whom I had no doubt I should soon become acquainted, I might hope to find the advice and assistance which would enable me to carry out the labors over which I had been pondering for some time. My mind was soon made up—'I must go to Paris.'"

The interest with which Dumas recounts this incident, which brought his stay in Geneva to a somewhat sudden termination, leaves no doubt as to the deep impression which the short intercourse with Alexander von Humboldt had made upon his mind. We have here, indeed, one more illustration of the peculiar predilection of the German *savant* for youthful inquirers, of the sagacity with which he discovered rising talent, and of the irresistible fascination which no one was able to withstand. It is well known what a powerful patron he proved to Liebig, who has left us a charming account of his first acquaintance with the famous traveler; and it is certainly worthy of note that two inquirers, whose labors subsequently carried them to the head of chemical science, should each have been befriended on the very threshold of his career by the same master mind, so that in later years they never ceased to acknowledge in affectionate terms the debt of gratitude which they owed to Alexander von Humboldt. Dumas's removal to Paris took place in 1823.

If a legitimate desire to become acquainted with the leading men of science of that day was one of the principal motives in determining Dumas to leave Geneva, his wishes were gratified far beyond his most sanguine expectations. Nothing could have surpassed the kindness with which the young aspirant was received by the very men to whom he had hitherto been looking up with mingled feelings of reverence and awe. As an illustration of the sympathetic interest which the most illustrious *savants* of the period accorded to the labors of their youthful fellow-workers in the field of science, Dumas is fond of describing his own *début* in the Academy of Sciences. Having read a joint paper of his and Prévost's on muscular contraction, he had modestly retired into the embrasure of a window (as would become his age), when a member of the Academy—a veteran with white hair and a most dignified countenance—rose on the other side of the table and walked up to him. "Monsieur Dumas, will you do me the honor of dining with me on Wednesday next?" he asked the astonished young chemist in a most formal manner. Nothing could be more natural than to accept so kind an invitation. After an exchange of a few polite words Dumas's new friend gravely retired to his place, receiving everywhere unequivocal marks of the greatest respect. "With whom am I to dine?" asked Dumas of one of his neighbors. "Do not you know M. de Laplace?" was the answer. And not only did Dumas dine with Laplace, but he learned with lively interest that the illustrious astronomer had retained a sort of passion for physiological inquiries ever since he had jointly worked with Lavoisier on animal heat and respiration.

In 1824 Dumas married Mdlle. Hermine Brongniart, daughter of Alexandre Brongniart, the illustrious geologist, and sister of his friend Adolphe Brongniart. The union was a most happy one. Dumas's career in Paris has been one of remarkable productiveness and brilliancy. His researches in organic chemistry, so thoroughly begun in

Geneva, were resumed and pursued with great ardor. He was the rival of Liebig, who so successfully cultivated the same field at the same time. But the two chemists, although often in sharp collision in their views, were ever firm, affectionate friends. Of their relation, Dumas remarked as follows:

"To find our way through these unexplored territories, we had neither compass nor guides, neither method nor laws. Each of us had been led to form ideas and to elaborate views peculiar to himself, which he defended with warmth and even with passion, but without any feeling of envy or jealousy. The discoveries to be made appeared to us without limit, and each was satisfied with his harvest. What we both had at heart was to stake the ground and to open roads, nor have I any doubt that, in reading my papers, Liebig felt the same pleasure which the perusal of his afforded me. If a new step had been taken, it was of little moment whether it had been made by the one or by the other, since it served us both on the road to truth." This generous feeling was heartily reciprocated by Liebig, who dedicated the German edition of his "Familiar Letters on Chemistry" to Dumas with the most cordial expressions of high regard.

It is impossible here even to name his scientific conquests. He early propounded new views of the atomic theory, which time has confirmed; and his experimental inquiries into the compound ethers laid the foundation of that branch of organic chemistry.

Dumas has been both a prolific and an elegant writer. His works present considerable variety, both as to the subjects discussed and to the form of treatment adopted. There are several elaborate treatises and a great many minor pamphlets. His academical notices, his official documents, his municipal reports, his festal speeches, his opening discourses, his commemoration addresses, his funeral orations, are countless, and they are all marked by an unusual degree of literary merit.

When the Republic was established in France, the President, Louis Napoleon, appointed Dumas Minister of Agriculture and Commerce; and when the Empire was established he became a Senator. His talents were now largely devoted to the public service, and he was the active spirit in numerous commissions in which his extensive and accurate knowledge was invaluable. With the overthrow of the Empire he returned to private life, and again resumed the scientific labors which have ever been his chief delight.

CORRESPONDENCE.

"WHAT THE EYE SEES IN READING."

Messrs. Editors.

IN your admirable cautionary note on "The Eyesight of Readers," in the September number of your magazine, you say, "A book of five hundred pages, forty lines to the page and fifty letters to the line, contains a million of letters, all of which the eye has to take in, identify, and combine each with its neighbor."

I believe you are wrong. I don't believe we deal with letters in reading at all, except when we meet unfamiliar words. I think persons, who read rapidly recognize words and phrases without analyzing them into their elements. I think that every word has a countenance, a physiognomy, which we soon learn, and which we afterward recognize as we do the faces of our friends.

Repeatedly I have amused myself by approaching an unfamiliar sign, or handbill, or printed page. What comes first into view? Not letters, but words; and they stand identified when no single letter can be distinguished.

It lies within easy observation that the lateral oscillation of the eyes of a rapid reader is very limited. Why? He cares so little about spelling the words he reads, that he does not even present to all of them the more sensitive spots on his retinæ, but is content to leave the images of most words upon more peripheral parts where they could not be spelled.

I would not presume to inform you of the brilliant success of the experiment of teaching children to read without spelling—an experiment which I believe has been most thoroughly tried in St. Louis. In the case of children so taught, words only are scanned, the young readers being wholly ignorant of the value of letters.

I have a correspondent whose written characters could not possibly be recognized, and yet to me his letters are fairly legible. Why? Because, however far he departs from the standard of the copy-book, he always writes any given word in the same way; and, although I could not *spell* isolated words from his written page, I have learned to recognize them as quickly as if they were fairly printed.

I think it might be successfully maintained that there actually is not time for each letter to be separately regarded, either by the eye or the mind, in rapid reading. I read the first three pages of the "Sketch of Joseph Leidy" in three minutes, and Abercrombie could have read it much quicker. In each minute I read four hundred words, containing more than two thousand letters. I submit that, while it is possible to see six or seven words per second, it is quite impossible to see thirty or forty letters per second.

DAN MILLIKIN.

HAMILTON, OHIO, *September* 10, 1880.

A CASE OF PROTECTIVE MIMICRY.

Messrs. Editors.

I VENTURE to send you an account of a sparrow's performance which I witnessed some time ago, and which you may consider worth publishing. It seems to me that the publication of such observations, when known to come from a trustworthy source and bearing the stamp of probable correct interpretation, is sure to add a light and pleasant page to our journals of popular science, as well as furnish a store from which illustrations may be drawn by those needing them. You have no reason to know me or my trustworthiness, but, that I do not depend upon imaginary data for such narratives as I send, I think I may refer you to my friend and teacher, Professor W. K. Brooks, of the Johns Hopkins University, or to Professor Martin, of the same institution, although I do so this time without their knowledge or permission.

Some time since, while riding slowly along a dusty macadamized road, I was startled by the hurried flight close by my side of a small bird which dropped in the road a few paces ahead, and after a flutter in the dust sat perfectly motionless. I drew up my horse to watch events, when a moment later a hawk swooped by, but missed its prey, and went off into an adjoining field. The sparrow remained still in its place, and, all covered with dust, looked for all the world like one of the many loose stones in the road—so much so, that no wonder it should have escaped the sharp sight even of the hawk.

But one explanation of such a freak seemed possible; and when we reflect that these birds generally take to the bushes or to the lichen-spotted rail fences, when pursued by hawks, and that dust is not a constant factor of the environment, we stop to admire so bright a spark of intelligence kindled under such trying circumstances.

Respectfully,

BOLLING W. BARTON, M. D.

BALTIMORE, *September* 30, 1880.

A SHOWER OF DUST.

Messrs. Editors.

In your July issue, I find a communication from Mr. Kirkwood, of Bloomington, Indiana, in regard to a deposit of dust that was observed there on the 28th March, 1880, and in which the theory is advanced, to account for its origin, that, since a similar phenomenon occurred in Europe almost simultaneously, both may be of common origin.*

The following is collated from the "Weather Review" (the official organ of the United States Signal Service) for March, 1880, and it undoubtedly leads us to infer that the Bloomington phenomenon and those treated in the "Review" were identical:

No. XV.—This area appeared in British Columbia, the afternoon of the 24th; Portland barometer 0·46, and Fort Benton barometer 0·45 below the normal. Moving southeastward, it was in Idaho the morning of the 25th, and by an easterly path was central in Nebraska the afternoon of the 25th, Omaha barometer 0·75 below the normal; at that time the pressure in the entire Missouri and upper Mississippi Valleys ranged from 0·40 to 0·75 below the normal. At midnight the area was central in Iowa, at which time the pressure over the greater part of the lower Missouri and upper Mississippi Valleys was 0·60 below the normal. At that time brisk easterly winds prevailed in the entire lake-region and Mississippi Valley generally, accompanied by rain, and brisk northerly winds from the Missouri Valley westward. On the morning of the 27th the area was central in eastern Iowa—Davenport barometer 1·04 below the normal—in the afternoon in northern Illinois, and at midnight in northwestern Ohio. During the day violent wind-storms (see data regarding local storms) occurred in the upper Mississippi and lower Missouri Valleys, and in the upper lake-region, westward from the Mississippi Valley to the Rocky Mountain slope, but little or no rain falling; remarkable dust-storms prevailed. Las Cruces, New Mexico, 26th, very violent sand-storm, filling the air with dust. Leavenworth, Kansas, 27th, blinding dust-storm, almost obscuring the sun at 10 A. M. Fort Davis, Texas, violent sand-storm. Ringgold, Ohio, 27th, heavy wind and hail storm. Professor Nipher, of St. Louis, Missouri, reports this storm "as the most remarkable phenomenon of the month. It covered the entire State, except the extreme southern part. The atmosphere was filled, during the whole day, with a fine grayish dust, which, in the western part of the State and in eastern Kansas, was so dense as to obscure the light of the sun, and to render objects invisible at a distance of from one to three hundred yards. The wind was very high, coming in most cases from the west and northwest."

P. F. Lyons.

Leavenworth, Kansas, *July* 28, 1880.

* In our opinion, Professor Kirkwood's letter will not bear this construction.—Ed.

MR. HERBERT SPENCER'S FACTS.

Messrs. Editors.

Allow me to say, respectfully, that Mr. Spencer impairs the public confidence in his conclusions by inattention to the reliability of what he states as facts. It is not enough that an author can cite book and page of some other writer in exact confirmation of his words. Responsibility for the truthfulness of the statement, which is the main thing, must rest upon him who repeats as well as on him who first puts it forth. A teacher of philosophy, especially, is bound to acquire a critical knowledge of the facts he uses, and to employ this knowledge judiciously for the benefit of those he attempts to instruct. In Mr. Spencer's preliminary article upon "Political Institutions," in the October number of "The Popular Science Monthly," the following statement occurs at page 6: "Having great cities of one hundred and eighty thousand houses, the Mexicans had also cannibal gods; . . . and, with skill to build stately temples big enough for ten thousand men to dance in their courts, there went the immolation of twenty-five hundred persons annually, in Mexico and adjacent towns alone, and of a far greater number throughout the country at large."

A few words concerning the *one hundred and eighty thousand houses* in the *pueblo*, not the city of Mexico. There is some difference in the estimates of the population of Mexico found in the Spanish histories, but several of them concurred in the *number of houses*, which, strange to say, is placed at *sixty thousand*. Zuazo, who visited Mexico in 1726, wrote "sixty thousand inhabitants," not houses (Prescott, "Conquest of Mexico," vol. ii, p. 112, note); the anonymous conqueror, who accompanied Cortes, says "sixty thousand inhabitants"—"*soixtante mille habitans*" (A. Tarnaux-Campans, vol. x, p. 92); but Gomara and Martyr wrote "sixty thousand houses," and this estimate has been adopted by Clavigero ("History of Mexico," Cullen's translation, vol. ii, p. 360); by Herrera ("History of America," London edition, 1725, Stevens's translation, vol. ii, p. 360), and by Prescott ("Conquest of Mexico, vol. ii, p. 112). Solis says "sixty thousand families," instead of houses or inhabitants ("History of the Conquest of Mexico," London edition, 1738, Townsend's translation, vol. i, p. 393). This guess would give a population of three hundred thousand, although London at that same time, after centuries of growth, contained but one hundred and forty-five thou-

sand inhabitants (Black's "London," p. 5). Finally, Torquemada, cited by Clavigero (ib., vol. ii, p. 360, note), boldly writes "one hundred and twenty thousand houses"; and now Mr. Spencer not only calls this Indian *pueblo* a "great city," but informs us that it contained "one hundred and eighty thousand houses." Torquemada had doubled the first estimates, and Mr. Spencer not only accepts the doubling, but adds upon some special authority an extra "sixty thousand houses," thus showing a tendency of mind to adopt the most extravagant views, where degrees exist. At five inmates to each house, it would give nine hundred thousand inhabitants. No doubt Mr. Spencer can furnish an authority of some kind for his "one hundred and eighty thousand houses," but that would not mend the matter, as the statement is simply so preposterous that Mr. Spencer is without excuse.

Nor is this the end of the difficulty. There can scarcely be a doubt that the houses in this *pueblo*, like those of the Indian tribes in New Mexico, and in Yucatan and Central America of the same period, were generally large joint-tenement houses, large enough to accommodate from ten to fifty and a hundred families in each. This, if true, raises the absurdity to the maximum point. Zuazo and the anonymous conqueror, who stated the population of Mexico at "sixty thousand persons," came the nearest to a respectable estimate, as they did not more than double the probable numbers.

I will say nothing of the annual number of human sacrifices stated at "twenty-five hundred in Mexico and adjacent towns," and, "far more than twenty-five hundred in other parts of the country," nor of the ten thousand dancers, who could dance in the courts of the great *teocalli*. By this carelessness concerning his statements, to put it in the mildest form, Mr. Spencer will inevitably draw and write upon some of his later works the old charge, *falsus in uno falsus in omnibus*. M.

A MINIATURE CYCLONE.

Messrs. Editors.

THE cyclone which visited a section of Montgomery County on the afternoon of the 3d of September, 1879, although insignificant in its extent and destructive power, when compared with some of those which occasionally ravage other regions of the country, possessed certain features that render it worthy of study. Its dimension and effects were such as to bring it within the compass of close examination, enabling the observer to view the phenomenon as a whole. It was a perfect little cyclone in itself, with the conflicting currents, the roaring noise, the numerous distinct whirls and the double cones in the air, with the uprooted trees on earth, all presenting a combination of features whose investigation may lend important assistance to the student of these universally interesting catastrophes.

A paper on this subject was read at one of our meetings, presenting such facts as had come at that time under the observation of the writer. Having made further explorations in conjunction with a friend who is also much interested in the phenomenon, we are prepared by a visit of inspection over the whole course of the storm, from its origin to the place of final disappearance, to make a statement of the principal facts just as they were seen.

The tree, which appears to have been the first object struck by the tempest, stands in the edge of a field prepared for sowing wheat, and covered with piles of manure. This tree was not uprooted, but the limbs were much blown about, some of them twisted round the main stem, and the singular appearance was presented of strands of manure blown into slight crevices of the trunk—sucked in, as it were, up to the height of fifteen or twenty feet; the heaps of manure were of course widely scattered.

Coming out of the field referred to, the storm fell in its fury on a family graveyard. Two large tombstones, ten feet apart, secured by iron pins let into an horizontal stone slab, were thrown flat in opposite directions, the one to the east and the other to the west of the path of the storm. The tombstones were three feet high, two feet wide, and six inches thick, weighing over three hundred pounds each. The general width of the current at this place appeared to have been about forty yards; but a tree one hundred yards east of the graveyard was much broken. Passing next through a corn-field, where the stalks in the middle lay in the direction of the path, and those at the edge leaned generally toward the center, on into a potato-patch, where some of the vines were blown out of the ground, bringing the tubers with them, the tufted weeds sharing the same fate, the winds, truly winged, vaulted over the fence without disturbing a rail, or the trees of a wood in their course for a space of some sixty yards. Then the whirling current descended, prostrating some trees as it entered a field, where it leveled the grass as if a roller had passed along, and made three distinct shallow holes in the ground, at least a foot in length. A few stones lying near, out of their previous place, appear to have been used by the wind as an agent in digging these holes.

After leaving this field, there was an interval of perhaps half a mile in which were but slight traces of the storm. It then swooped down upon a forest thick with large trees, a number of which were uprooted, lying in different directions, and others with their upper limbs and tops much twisted

and broken. Leaving this, the cyclone fell into a meadow, then rose, and, after a course of a few hundred yards, it descended upon an elevated section of forest. Here, about the middle of its course, the destruction was most apparent, in the way of uprooted and broken timber; and so unconformable was the lay of the prostrate trees, as to defy all the ordinary theories of cyclones.

But this spot afforded clear evidence of the successive ascent and descent of the whirling current as it swept along; for the trees where it entered the forest had only their tops and upper limbs twisted and mutilated, a series of whole trees uprooted following in the path, while again the destruction was confined to the top at the place where the storm left the woods.

The next remarkable object was a cornfield, in which the damage was conspicuous. The stalks were stripped and some blown out of the ground. The earth looked as if scraped by some hard substance. A tenant-house was next on or near the route, but the damage was slight; a shutter was blown away, only pieces of which could be found. A bed in this house was blown against the window. Farther on, a stable was partly unroofed, and a corn-house lifted up from the piers that supported it, transported a few feet, and so gently deposited that a full hogshead of wheat uncovered was let down without spilling more than a few grains. The alarmed owner found himself unable to open the door of his house. Thus far the force of the storm had been directed only against trees of the forest; it now struck the orchards of two adjoining farms, leaving sixteen fine apple-trees prostrate.

In one of these, the trees were strewed on the ground almost in the direction of the spokes of a wheel. For the next half mile very little damage was done, the path being marked by a few broken limbs of trees. But the storm came down once more, and uprooted a number of large trees, quite in a valley.

Its violence was now exhausted; we followed the path with some difficulty half a mile farther, and then no more traces of it were to be found.

The cyclone, after a course of about five miles, ascended and dissolved away into the upper air. No part of the phenomenon was more clearly indicated than this alternate descent and rise of the whirling column as it moved along. This was manifest not only from observation of the objects on the route, but was plainly seen by persons who watched the current from neighboring hills. Filled with dust and leaves and boughs of trees, and distinctly colored, the contiguous separate whirls formed a spectacle of terrible grandeur as seen from elevated points at a distance. There were slight occasional zigzags in the route, but for the most part it was remarkably direct, with a course bearing about ten degrees east of north, and a width varying from thirty to seventy yards.

In regard to the velocity of the current, no precise estimate can be made. The nearest approach to it would be to say that the course of five miles appears to have been accomplished in about five minutes.

Two facts afford some indication as to the dimension of the whirls that were continually forming and changing in the progress of the cyclone. In the case of the orchard-trees, described as lying somewhat in the form of spokes of a wheel, the diameter of the whirl must have been about thirteen yards, while in the graveyard it could not have exceeded ten feet.

Some persons heard, during its progress, what they liken to explosions. Some also heard a noise resembling the roar of a railroad train, before it began its course below.

Immense cumuli clouds were piled up over the storm-clouds, their brightness contrasting strongly with the black and threatning appearance of the latter.

WILLIAM HENRY FARQUHAR.
HENRY C. HALLOWELL.

ROCKLAND SANDY SPRINGS, MARYLAND, *March* 24, 1880.

EDITOR'S TABLE.

SIR JOSIAH MASON'S SCIENCE COLLEGE.

SIR JOSIAH MASON, the founder of a new Science College, in Birmingham, England, is an old gentleman of eighty-six who has considerable reputation as a rich philanthropist. He amassed an immense fortune by the manufacture of a steel pen of famous reputation and by the business of electro-plating. He spent large sums in establishing hospitals, asylums, and almshouses, and endowing them for the benefit of deserving persons in want; and, among other public charities, he built and endowed an orphanage capable of receiving, educating, feeding, and clothing five hundred orphan children

who were to be helped without regard to their nationality or religion. His last great benefaction is the establishment and the equipment of a Science College, "to provide for a thorough systematic education in science with a distinctly practical application to the industries of the Midland district and particularly to those of Birmingham (in which the founder has spent the greatest portion of his life), and of Kidderminster, where he was born."

Two courses of study are provided for in the deed of foundation. The course of regular systematic instruction is to be of such a kind as shall qualify students either for passing the examinations necessary to obtain the degrees of Bachelor of Science, or of Doctor of Science, of the University of London; or for any profession or pursuit in which scientific knowledge can be usefully applied. Besides this there is a course of popular instruction in the practical applications of science which it is intended shall be given by means of evening lectures to artisans and others who can not attend the classes of regular systematic instruction. All departments in the college are open to both sexes on the same terms. The faculty consists of able men carefully chosen, and the institution was opened October 1st, with an introductory address by Professor Huxley on "Science and Culture," which is herewith reprinted.

Professor Huxley's interesting discourse was well suited to signalize the occasion which called it forth; but on the other hand there was that in the occasion which gave a telling emphasis to the discussion. The Mason College was put upon a new basis. It was to be broadly devoted to science, and, to prevent interference with this distinctive and comprehensive purpose, its founder excluded "theology," "party politics," and "mere literature" from its scheme of studies.

In thus constituting his college, Sir Josiah Mason must be regarded as representing a pronounced tendency of the age. But the theory of education embodied in his institution was the result of extensive practical intercourse with the common people, and an intimate knowledge of their real wants. He was not an enthusiastic scientific student, run away with by a hobby, but a cool-headed observer of affairs, and the bold ground that he took testifies to both his sagacity and his independence. The founders of colleges and universities are usually ambitious to enlarge their schemes of study, so that "all knowledge" may be obtainable within their precincts. Sir Josiah Mason had the good sense to recognize that, in all such attempts, traditional and fashionable studies will usurp the places of those that are really far more valuable; so he determined to keep out those subjects which would hinder instead of promoting scientific proficiency. It was a plucky thing to do in England, where the reverence for old classical literature amounts to a superstition, while acquaintance with it is held as the sole test of a liberal education.

It would probably not have made much difference what educational absurdity an old man might have perpetrated, as he was himself unlettered, and his college was to be a mere vulgar, useful knowledge dispensatory for working people. But when Professor Huxley came forward and endorsed the wisdom of the founder, and when, moreover, he began to talk about a new and higher type of culture, the offspring of modern thought, and grounded upon science, there were at once symptoms of perturbation and perplexity in the literary circles. There was not, as there could not be, any intelligent controversy with the Professor over the positions he took; but the proprieties had been shocked, and the real question was, where *did* Huxley stand, and what *could* the man mean? His concessions, as the reader will see, were large, but that availed little, if he denied the exclusiveness of the

old university ideals of culture. The whole pinch is here, for, whenever science is recognized as the foundation of a valuable and desirable mental culture, the progress of thought will soon give it the supreme place as a means of the higher education.

CURIOUS EDUCATIONAL LOGIC.

THE rapid development in this country of a vast system of state education, under the control of politicians, gives interest to the views of those men on the subject of educational philosophy. President Hayes in his speech, which we referred to last month, is reported to have made the following remarkable statement: "The unvarying testimony of history is that the nations which win the most renowned victories in peace and war are those which provide ample means of popular education." That is, according to the President of the United States, popular education is equally a preparation for victories in peace and victories in war—the destructive practice of savages and the constructive vocations of civilized life. It has been the inspiring hope of multitudes through many ages that the world would yet outgrow the brutal pursuit of war, and they have had faith that this great result would be ultimately achieved by the progress of general enlightenment and the development of the arts of peace which communities would find it for their highest interest to promote. It has been believed that the victories of peace would put an end to the curses of war, because the state of mind they would engender in society must be incompatible with military barbarism. Certainly, if there is deadly antagonism anywhere it is between the interests of war and the interests of peace; but President Hayes seems to think popular education has the marvelous capacity of leading both ways, to triumphant war and victorious peace.

We need not go far for illustrations of inveterate hostility between the interests of peace and war, and for the influence of this conflict in shaping the permanent policy of government. The antagonism casts its malign shadow over all the periods of peace. The commerce and industry of the country are "regulated," not by the intrinsic laws of commercial and industrial prosperity, but with reference to the alleged contingencies of future war. Why should the intercourse of nations be impeded by shackles upon trade? Why should private enterprise be thwarted, and the intelligence of citizens discredited in regard to the course of industrial occupation? Because at some future time we may want to fight the world, and so must keep ourselves independent of it. We are cursed with a war-tariff because we had a domestic war, and must continue it because we may have foreign wars; and thus citizens are coerced this way and that in all their most vital private interests by the predominance of the military spirit.

A more specific illustration is fresh in the minds of all. The opening of a canal at the Isthmus of Darien would be one of the greatest victories of peace in the interest of the world that has ever been accomplished. It would bind the nations in pacific restraints more powerfully than any other international measure ever proposed. But it was resisted in this country in the interests of future war; and President Hayes and the politicians of Congress did all they could to prevent the execution of the work by a disgraceful demagogical perversion of the Monroe doctrine. The popular education of the politicians did not here lead them both ways, according to Hayes's formula; they sacrificed the victories of peace on the pretext of the adverse interests of future war.

President Hayes invokes "the unvarying testimony of history" to establish his proposition, but the problem of the influence and effects of "popular

education" is hardly yet historical. Not many "nations" have gone far into the experiment; those which have done so are recent, and the results by no means confirm President Hayes's conclusion. Prussia leads in popular education, and that education is tributary, not to the victories of peace, but to the victories of war, the first fruit of which is a grinding military despotism. The popular education of Germany, moreover, exemplifies in a marked degree the antagonism we have referred to, and is wholly subordinated to military ends. The following remarks of Professor Dabney, in a late number of the "Princeton Review," bear decisively upon this point: "Recent history is more instructive, because it offers us illustrious experiments of popular education carried for two generations as far as it is ever likely to be carried. Our overweening hopes of good from mere mental culture are much curtailed by observing that the condition of Christendom was never more ominous and feverish than it now is, after these efforts at education. Military preparations were never so immense, or so onerous to the national industry. The spirit of war was once ascribed to the ambition of kings, regardless of the blood of their peace-loving subjects. But we now see that, since the instructed peoples have acquired influence in the governments of Europe, this fell passion is more rife than ever. It seems, moreover, that the German nation, the most educated one of all, is in as unstable a condition as the rest. The wildest political heresies prevail; and these rulers, the special and boasted exemplars of popular education, rely least on popular intelligence, and most on the sword, to save society from destruction. Intelligent men there dismiss the idea with ridicule that any actual diffusion of intelligence among the peasantry, by the schools, is the real safeguard of their universal suffrage. They tell us that not one in three exercises his accomplishment of reading when an adult—a statement which the scanty circulation of newspapers among them confirms. They say that the primary schools are useful chiefly as *a drill in obedience*. They teach the child early to submit to superiors, to move at the sound of a bell, to endure tasks, to fear penalties, to study punctuality, at the command of others. Then comes the conscription, and seven years' drill in arms, to confirm the habit of submission. Thus the German system produces a peasant who is in the habit of voting as the upper classes bid him, not of thinking for himself! It is presumed that this picture of the virtues of the system is not very flattering to our American hopes."

DR. EDOUARD SEGUIN.

In the death of Dr. Seguin, which occurred October 28th, the community has lost a man of genius and also of peculiar and eminent usefulness. Though a physician, and devoting himself to a specialty in his profession, the results of his studies are of very broad application, and are sure to be increasingly appreciated in the future.

Dr. Seguin was born at Clamecy, in France, in 1812, studied medicine and surgery in Paris, and early devoted himself to the investigation of nervous diseases, and particularly to the nature and treatment of idiocy. When he took up the subject of the education and training of the weak-minded, it had been but very little explored; there was profound and widespread ignorance of all its principles, and it was hedged about by inveterate prejudices and superstitions. In the seventeenth century St. Vincent de Paul gathered a few idiots and labored assiduously for years to instruct them, though with very little success. In 1799 Jean Gaspard Itard, an eminent French surgeon and a disciple of Condillac, grappled with the problem in the case of the

"wild boy of Aveyron." This was an idiot found in the forests of Aveyron, and who was taken up by Itard for the purpose of solving "the metaphysical problem of determining what might be the degree of intelligence and the nature of the ideas in a lad who, deprived from birth of all education, should have lived entirely separated from the individuals of his kind." The philosophy of the time was consonant with its theology; for, while theology taught that man is fallen from a primitive state of paradisaical innocence, philosophy held that he has fallen away from the perfection of a "state of nature." Hence there was great curiosity to find out what would be the state of mind of one who had not been perverted by association with civilized people. Nothing, of course, came of Itard's experiment, except that he had got hold of an idiot of low grade, and satisfied himself that it might be possible to improve such natures in some small degree.

Dr. Seguin was a pupil of Itard (who lived till 1838), and, receiving from his teacher the facts and results that he had gathered, young Seguin entered systematically upon this line of study. The subject was beset with great difficulties, and the young Frenchman entered upon it with enthusiasm as a labor of love, and devoted several years to a thorough research into the causes and philosophy of idiocy and the best methods of dealing with it. As the investigation was a practical one, Dr. Seguin organized schools in connection with public institutions and also under private control; and it was the successful results in these establishments which became the basis of his numerous publications on his chosen subject. In 1839 he published, in connection with the celebrated alienist Esquirol, his first pamphlet; and in 1846 he put forth an elaborate treatise expounding his system of the treatment of the idiotic and weak-minded. This work became at once the authorized text-book of the subject, and placed its author in the front rank of living physiological psychologists.

Dr. Seguin came to this country in 1848, and resided for ten years in Ohio. He then returned to Paris, but came back in 1862, and has lately resided in New York. He continued his observations and inquiries on the subject of idiocy in this country, and organized several institutions devoted to their care and training. He, moreover, had the satisfaction of seeing the rise of a great number of schools for the feeble-minded and lowly organized, which adopted his methods of cultivation with remarkable success. To him, in fact, more than to any other man, belongs the immortal honor of showing to what a degree the badly-born—the congenital failures of nature—can still be redeemed and elevated to comparative usefulness. How much has been thus gained by the combination of scientific knowledge and skillful, persevering art is thus stated by Professor Seguin himself: "Not one in a thousand has been entirely refractory to treatment; not one in a hundred who has not been made more happy and healthy; more than thirty per cent. have been taught to conform to social and moral law, and rendered capable of order, of good feeling, and of working like the third of a man; more than forty per cent. have become capable of the ordinary transactions of life under friendly control, of understanding moral and social abstractions, of working like two-thirds of a man; and twenty-five to thirty per cent. come nearer and nearer to the standard of manhood, till some of them will defy the scrutiny of good judges when compared with ordinary young women and men."

Dr. Seguin was the author of many publications, the last of which was the second edition of his "Report on Education" as United States Commissioner at the Vienna Universal Exposition. We noticed this report upon its first appearance, but a revised edition appears

this year from the press of Doerflinger, of Milwaukee, Wisconsin. This little volume is of much interest to educators. It treats the subject by the physiological method, which is the point of view to be taken in the education of childhood. Part I is devoted to Infant Education, the Kindergarten, and what are called Physiological Infant Schools. Part II considers the Education of Deaf Mutes; Part III the Education of Idiots; and Part IV applies the results arrived at to Popular Education as it is and as it should be. The book is full of valuable information and pregnant suggestions, taking their complexion from the author's professional experience, scientific observations, and peculiar line of studies.

We began by remarking that Dr. Seguin's special studies have a breadth of application that reaches far beyond the technical schools for the feeble-minded. He has taught the world the difficult task of elevating idiots into rational beings. An intelligent appreciation of his philosophy might at least prevent us from doing the opposite—turning rational beings into idiots in our popular schools. If any are curious about the *rationale* of this process, we refer them to the article on "The Artificial Production of Stupidity in Schools," in the second number of "The Popular Science Monthly."

LITERARY NOTICES.

ODONTORNITHES: A Monograph on the Extinct Toothed Birds of North America. With Thirty-four Plates and Forty Woodcuts. Forming Vol. VII of the Geological Survey of the Fortieth Parallel. By OTHNIEL CHARLES MARSH, Professor of Paleontology in Yale College, New Haven, Conn.

FOSSIL anatomy is generally regarded as one of the driest of subjects; but, when the vestiges of old bones become the keys to the history of the world and the mysteries of the universe, their study acquires an intense interest. No better exemplification of this can be found than that furnished by the author of the splendid monograph before us. Professor Marsh, as is well known, has been engaged for the last ten years in exploring the Rocky Mountain regions in search of fossils, and his enthusiasm, untiring energy, and whole-souled devotion to the work well attest the fascination there is to the scientific mind in inquiries which the mass of people are apt to regard with indifference.

Two circumstances combined to give especial and powerful interest to the investigation. The region was rich in new material for paleontological science, and the facts discovered were certain to have great significance in their bearing upon biological theory and our whole view of the economy and order of nature.

Geology tells us, in the first place, that the North American stratified rocks, over vast areas west of the Mississippi, were deposited in a continuous, tranquil way, and were so little disturbed by revolution and upheaval that the formations are found in a remarkably unbroken sequence. The geological systems follow each other regularly, so that the record is in an unusual degree complete. But, while the strata under the vast prairies remain nearly horizontal as they were left by deposit and subsidence, the beds have been denuded, and thrust up here and there so that the outcropping strata are open to examination. The maximum thickness of these formations is estimated at some seven or eight miles, and the "stratigraphical succession" is so perfect as to be most favorable for the study of the order and dependence of the extinct forms of life. Thus the field was not only fresh, but propitious for new paleontological exploration. In the second place, this interest was heightened by the crisis of biological speculation. The theory of the continuous evolution of living forms by descent with variation had got a foothold with naturalists, but evidence was sorely wanting to supply the missing links in the chains of organic succession. There was a demand for "intermediate types," and that the connecting forms predicted by the evolutionists should be forthcoming. The research had a factitious interest from these circumstances. Professor Marsh was, of course, animated by the genuine scientific motive of finding

out the facts, whatever theories they might favor; but he could not be insensible to the import of his labors.

Some idea of the immense value of Professor Marsh's contributions to paleontology, as well as the immense labor that they have cost, may be gathered from the fact that in the last twelve years he has enriched the museum of Yale College alone with about one thousand *new species of extinct vertebrates*, at least one half of which remain to be studied out and described. That which is remarkable about these collections is the excellence of their preservation, and the profusion of specimens by which it becomes possible to restore nearly completed skeletons. Paleontologists have hitherto had to work much from fragmentary specimens; but Professor Marsh is now enabled to restore the extinct vertebrate forms of the Western Cretaceous beds with such fullness of detail as seriously to affect the literary treatment of the subject. His large memoirs will be confined to a few restorations, but the work in each case will be a finished contribution to which little can ever be added.

The present memoir on "Extinct Toothed Birds" is his first systematic publication on the Western fossils, and forms Volume VII of the "Geological Survey of the Fortieth Parallel," conducted by Mr. Clarence King; and it also forms Volume I of "Memoirs of the Peabody Museum of Yale College." In regard to its contents, we can not do better for our readers than to reproduce the following extract from a notice of it in "Nature," by Professor Geikie, the able head of the Geological Survey for Scotland:

Among the organic wonders of which from time to time during the past decade announcements have appeared, none have been received with more interest than the discovery of birds with teeth, made by Professor Marsh near the end of the year 1870, in the middle Cretaceous rocks, which in Kansas and Colorado spread out eastward from the base of the Rocky Mountains. So perfect a matrix do the peculiar buff, chalky, or marly beds of the Kansas middle Cretaceous formations furnish for the preservation of organic remains, that almost every bone of the skeletons of some of the birds has been recovered. The material for the study of their osteology is thus almost as ample as that for any living bird. Full advantage of this abundant store of material has been taken. The cases and cellars in the Peabody Museum at New Haven contain the remains of about fifty different individuals of a single bird. Every bone of its skeleton, with the exception of one or two terminal toe-bones and the extreme point of the tail, has been recovered, and is here carefully drawn of the natural size. Never before has it been possible, we believe, to reconstruct so perfectly so ancient an organism.

The volume is divided into two parts. In the first of these the detailed structure is given of the bird on which the author has bestowed the name of *Hesperornis*. The skeleton of this animal if extended to its full length would measure about six feet from the point of the bill to the end of the tail. It must have been a typical aquatic bird, without any power of flight, but with strongly developed limbs and a long, flexible neck, whereby it was doubtless endowed with remarkable powers of diving and swimming, and of seizing the abundant fishes of the shallow seas in which it lived. Compared with our modern birds, the two features of this ancient form which most forcibly arrest attention are the teeth and the legs. The teeth were covered with smooth enamel, terminating upward in conical pointed crowns and downward in stout fangs, closely resembling those of mosasauroid reptiles. Their mode of growth and replacement have been determined to have taken place in a manner very similar to that in some reptiles, the young tooth forming on the inner side of the fang of the tooth in use, and increasing in size, while a pit for its reception was gradually made by absorption. The old tooth, being progressively undermined, was finally expelled by its successor, the number of teeth thus remaining unchanged. The teeth were implanted in a common alveolar groove, as in *Ichthyosaurus*. In the upper jaw they were confined to the maxillary and entirely absent from the pre-maxillary bone; in the lower jaw they extended from near the anterior extremity of the ramus along the entire upper border of the dentary bone. Mr. Marsh believes that they were held in position by cartilage which permitted some fore-and-aft movement, but on the decay of which after death the teeth readily became displaced and fell out of the jaw. This is an important fact in its bearing upon the nature of the teeth found on the same slab of Solenhofen limestone with the well-known *Archæopteryx*. These teeth, it will be remembered, were referred by Mr. Evans to the bird itself—a reference fully confirmed by Mr. Marsh, who says that he at once identified the teeth as those of birds and not of fishes, and by the subsequent discovery of other remains of the bird. In *Hesperornis regalis* there appear to have been fourteen functional teeth in the maxillary bone, and thirty-three teeth in the corresponding ramus of the lower jaw. The wings are rudimentary or aborted, a remnant of the humerus alone existing. They may have gradually diminished from disuse until, as the power of flight ceased, the legs and feet increased in proportion, and assumed the massive dimensions shown in these specimens, or, as Mr. Marsh suggests, the bird may have been a carnivorous aquatic ostrich, never having possessed the power of flight, but descended from a reptilian ancestry, which is strongly

recalled by different portions of the skeleton. Among recent birds, the peculiar legs and feet of *Hesperornis* find their nearest analogues in the Grebes of the genus *Podiceps*. They were admirably adapted for propulsion in water, but scarcely served for walking on land. Locomotion must have been entirely performed by the posterior limbs—a peculiarity which distinguishes *Hesperornis* from all other aquatic birds, recent or fossil. The tail appears to have been composed of twelve vertebræ, unique in their peculiar, widely-extended, transverse processes and depressed horizontal plowshare bone. Broad and flat, somewhat like that of the beaver, it must have been a powerful instrument in steering the bird through the water.

The second part is devoted to a description of the remains which have been found of birds belonging to a second order of Odontornithes, termed *Odontotormæ*. Unlike *Hesperornis*, they seem to have been all of comparatively small size and to have possessed powerful wings, but very small legs and feet. From that contemporaneous form, and from all other known birds recent and fossil, they are distinguished by certain types of structure which point back to a very lowly ancestry, lower even than the reptile. Their bones, being mostly air-filled, would enable the carcasses to float on water until, by decay or the rapacity of other animals, they were separated and dispersed. Hence skeletons of these flying birds are less entire than those of the massive-boned *Hesperornis*. Nevertheless, the remains of no fewer than seventy-seven different individuals have been disinterred. These are included in two well-marked genera, *Ichthyornis* and *Apatornis*, and were all small birds, reminding us by their strong wings and delicate legs and feet of the Terns, like which they were probably also aquatic in habit. Besides the reptilian skull and teeth, the birds of this second order were marked by the character of their vertebræ, which in their biconcave structure recall those of fishes. This is the more remarkable, as in *Hesperornis* the vertebræ are like those of modern birds. Yet these two utterly dissimilar types were contemporaries, and their remains have been preserved in the same strata. Mr. Marsh points out that the transition between the two vertebral types may be traced even in the skeleton of *Ichthyornis* itself, where the third cervical vertebra presents a modification in which the ordinary avian saddle-shaped form appears as it were in the act of development from the biconcave ichthyic form.

This memoir and those which will succeed it have a weighty interest as contributions to the doctrine of organic evolution. There is no other possible way of explaining the numerous facts than by this theory. Professor Marsh's discoveries are new demonstrative proofs of the law, which he has done more to confirm by these fossil revelations than any other living man, or all contemporary naturalists put together.

It remains only to add that the volume in all its elements—paper, printing, drawing, and engraving—is superb. The illustrations, all executed in New Haven, and by the most skillful hands the world affords, are the perfection of art. Professor Geikie pays them the following high but deserving compliment: "They are strictly and rigidly scientific diagrams, wherein every bone and part of a bone is made to stand out so clearly that it would not be difficult to mold a good model of the skeleton from the plates alone. And yet, with this faithfulness to the chief aim of the illustrations, there is combined an artistic finish which has made each plate a kind of finished picture." Should the series of memoirs of the Peabody Museum of Yale College, of which this is the first, be carried out on a scale and with a thoroughness here attained, it will form one of the great scientific monuments of the century.

GERMAN THOUGHT. By KARL HILLEBRAND. New York: Henry Holt & Co. 1880. Pp. 298. Price, $1.75.

IN these six lectures before the Royal Institution of Great Britain, Professor Hillebrand has traced in outline the rise of modern German thought and its influence in forming modern German political life. The period covered by his review is that from the Seven Years' war to the death of Goethe, but he glances briefly at the part taken by the other nations in the work of modern culture, as an indispensable preliminary to the subject proper. His review leads him to a consideration of the Italian Renaissance, in which Italy led the way in breaking from the thralldom of mediæval tradition and authority; the reaction against the sensuous view of life that this introduced, which in Spain was expressed by the founding of the Society of Jesus, and in Germany by the Reformation; and the passing to England and Holland, and later to France, of the leadership in the thought and spirit that have made modern Europe. Though Germany held an important place in the initial movement, she took but little part, Professor Hillebrand points out, in the subsequent progress of it. She had been engaged in one of the most notable struggles in history, and came out of it prostrate. The Thirty Years'

war not only left her in entire intellectual, moral, and material poverty, but it completely broke the thread of her history, and threw her back full two hundred years. It was not until 1760 that she began "to react against the too absolute thought of France, and to begin the work of restoration on a sounder basis than that which Spain had tried to lay two centuries before." Her restoration was due to two things—the Prussian state and the Protestant religion. The one has gradually molded out of an heterogeneous mass of petty principalities a powerful state, and the other awakened thought, and furnished the conditions in which free inquiry could thrive. The impulse to a large intellectual life came from without, but, once given, a literature grew up which has expanded into a rich and varied product. It has now become national in its tone and feeling, but at first it was purely individual. It is the peculiarity of German literature that it arose, not, as in other countries, after a coherent state had been formed, but before, while yet the nation did not exist, and Germany was but a collection of petty states. It had the task not only of responding to a national spirit, but of forming that spirit. At first, as Germany began to recover from the prostration of its protracted war, the literature was but a soulless copy of foreign models, but with time it grew to be more and more national, and under the impulse of the Seven Years' war it took definite form, and prepared the ground for the generations of great writers which have finally placed Germany abreast of the other foremost nations of Europe. The three generations of writers who did the great literary work of Germany were those born in the sixty-five years from 1715 to 1780, and which followed each other at periods of twenty years. In the first were Klopstock, Wieland, Winckelmann, Kant, Mendelssohn, and Lessing; the second included Herder, Voss, Klinger, Bürger, Goethe, and Schiller. The third and final generation gave to Germany the two Schlegels and the two Humboldts, Rahel, Tieck, Schleiermacher, Niebuhr, Savigny, and Schelling. The "two schools," says Professor Hillebrand, "which from 1825 to 1850 influenced the German mind most powerfully, the school of Hegel and that of Gervinus, only continued, developed, summed up, applied, or contradicted the main ideas of the three preceding great generations." The period of the first two generations was the creative one, when Lessing and Kant, Herder and Goethe and Schiller were leading German thought into new channels. The later period—that of the Romanticists—was essentially a reactionary one, a period in which the middle ages became the ideal. It was, however, a necessary one, and under its influence the past of Germany was brought into prominence, and this prepared the later generation for the constructive work of organizing the German state and arousing the feeling of patriotism essential to its success. When this task has been fully accomplished, Germany can again take up the work of intellectual progress and occupy her place in the general movement of European thought. Professor Hillebrand writes in a very agreeable style, and, though he is confined to a brief outline, he invests his subject with an interest that is sustained to the end.

THE ELEMENTARY PRINCIPLES OF SCIENTIFIC AGRICULTURE. By N. T. LUPTON, LL. D., Professor of Chemistry in Vanderbilt University. New York: D. Appleton & Co. Pp. 107. Price, 50 cents.

THIS little primer of agriculture for the public schools had the following origin: The Legislature of Tennessee passed a law authorizing the Superintendent of Public Instruction and the Commissioner of Agriculture to procure the preparation of a suitable elementary work on agricultural science, to be used in the common schools of that State. The Commissioner selected Dr. N. T. Lupton, Professor of Chemistry in the Vanderbilt University, to prepare the book, and this little volume is the result. As our public schools are constituted, it is perhaps as good an introductory book as could be got upon the subject. It is written in a clear and easy style, with the smallest possible amount of technical scientific talk that is consistent with a rudimentary exposition of agricultural principles. After some appropriate opening remarks on the development of scientific agriculture, the author takes up the origin, composition, and classification of soils, the composition of plants, the composition and properties of the atmosphere, and

the sources of plant-food and how it is obtained. This is the most purely scientific part, as all the explanations depend upon chemistry. The author then takes up the questions of the improvement of soils, the use of manures, mineral fertilizers, rotation of crops, and the selection and care of live-stock. This is the more practical portion of the book, and is full of well-digested information which should be got early into the heads of farmers' boys. There is an appendix describing a few simple experiments, and then the customary questions to aid the teacher in the recitations.

SUMMER-LAND SKETCHES, OR RAMBLES IN THE BACKWOODS OF MEXICO AND CENTRAL AMERICA. By FELIX L. OSWALD. With numerous Illustrations. Philadelphia: J. B. Lippincott & Co. Pp. 425. Price, $3.

THIS is a book of travel, adventure, and observation in a wild and picturesque region, upon which pen and pencil have been hitherto but little employed. It is besides a scholarly study of the scenery, the natural objects, the art-works, and the habits and characters of the people that were met with, and it is full of acute reflections and an instructive philosophy thoroughly imbued with the modern scientific spirit. Its style is, moreover, vivid, racy, crisp, and lively, so that altogether the work may be commended to the reader as fresh, original, brilliant, and solid.

Dr. Oswald was stationed at Medellin, near Vera Cruz, in 1867, as director of a military lazaretto. Transferred afterward to the Vera Cruz City Dispensary, he lost his health, and, having got a notion that the mountains of Mexico have great sanitary claims, he resolved to go there and if possible reëstablish his constitution. He rambled about for several years, and this volume is one of the results of his experience. Dr. Oswald has very decided views in regard to some of the evil tendencies of civilization, and was very happy in the great region that has not yet been invaded by the destructive agencies of civilized life.

The following extract from his introduction, shadowing forth this idea, explains the production of the book, and illustrates the characteristics of the author's writing:

In the course of the next eight years I explored the highlands of Jalisco, Oaxaca, Colima, and Vera Paz for the benefit of my own health or that of my employers, but, like the Catalan farmer, I found more than I sought. Independence, in the political sense, and a healthy climate, might be found in the mountains of Scotland, and even of Old Spain; but the new Spanish sierras can boast of a virgin soil, with primeval forests which offer a sanitarium to all who seek a refuge from the malady of our anti-natural civilization —from the old *marasmus* which has spread from the Syrian desert to the abandoned cotton-fields of Georgia and Alabama.

We vaunt our proficiency in the art of subjugating Nature, but in the New World the same ambition has led to a very dear-bought victory, which the countries of the East have paid with the loss of their manhood; their wild woodlands have been tamed into deserts, and their wild freemen into slaves; the curse of the blighted land has recoiled upon its devastators. In our eagerness to wrest the scepter from our Mother Earth, we have invaded her domain with fire and sword, and instead of increasing the interest of our heritage we have devoured the principal; the brilliant progress of the vain god of earth is tracked by a lengthening shadow—the day-star of our empire is approaching the western horizon.

Where shall it end? Mold, sandy loam, and sand, is Liebig's degeneration scale of treeless countries; the American soil may pass through the same phases, and what then? Will the sunset in the West be followed by a new Eastern sunrise? Shall Asia, the mother of religions, give birth to an earth-regenerating Messiah, whose gospel shall teach us to recognize the physical laws of God? Or shall the gloaming fade into the night of the Buddhistic Nirvana, the final extinction of organic life on this planet? It is not much of a consolation to think that in the latter case the nations of the higher latitudes might count upon a protracted twilight. The westward spread of the land-blight will drive the famished millions of the Old World upon our remaining woodlands, but the resources of the last oasis will probably be husbanded with Scotch canniness and Prussian systematism, and before we share the fate of the Eastern nations we may see the dawn of the bureaucratic millennium, when all our fields shall be fenced in with brick walls, all rivers with irrigation-dikes, and all functions of our domestic life with official laws and by-laws. My trust in the eternal mercy of Providence lets me expect another deluge before that time; but the recuperative agencies of unaided Nature seem powerless against the greatest of all earthly evils. National and territorial marasmus are incurable diseases; the historical records of the Eastern Continents, at least, prove nothing to the contrary. The coast-lands of the Mediterranean were the pleasure gardens of the Juventus Mundi, the Elysian Fields whose inhabitants celebrated life as a festival; and now? Spain, southern Italy, Turkey, Greece, and Persia have been wasted to a shadow of their former self; ghouls and afrits

haunt the burial-places of the north African empires; and no invocation can break the death-slumber of Asia Minor. Acorns perish in the soil which once nourished the oaks of Bashan; outraged Nature refuses to be reconciled. With the glory of the Orbis Romanus the spring-time of our earth has departed, and what America mistakes for the prime of a new year is but the lingering mildness of an Indian summer.

The career whose swiftness is our national boast has led us upon a road which has never been far pursued with impunity; the rapidity of the destruction of our tree and game production is far more unparalleled than the growth of our cities; the misery of the Old World has not taught us to avoid its causes, and the history of its effects will not fail to repeat itself. On the frozen shores of Lake Winnipeg and the inaccessible heights of the central Rocky Mountains a few remnants of the old forests will probably survive; but the great East-American sylvania is already doomed; if we persist in our present course, our last timber-States, Maine, Michigan, and North Carolina, will be as bald as northern Italy in fifty years from now, and our last game will soon retreat to the festering swamps of southern Florida.

The temperate zone of America will soon be the treeless zone, with a single exception. In the sierras of southern Mexico large tracts of land still combine a generous climate with a rich arboreal vegetation. Mexico, like our own republic, has her backwoods States, but their security from the inroads of the destroyer is guaranteed by better safeguards than their remoteness from the great commercial centers. The ruggedness of the surrounding sierras, the supposed or real scarcity of precious metals, and the independent character of the aboriginal population, all conspire to make the *alturas* or mountain forests as unattractive to the imperious Spaniards as they are inviting to freedom-loving visitors from the North.

To my rambles and adventures in these *alturas*, to their scenic charms, their strange fauna and vegetable wonders, I have devoted this volume; but I have rarely touched upon the mineral and agricultural resources of a region which should remain consecrate to the Hamadryads and their worshipers. The cities of the intervening "civilized" districts, too, I have only mentioned as wayside stations for the benefit of non-pedestrian tourists. New Spain makes no exception from the general rule that the nations of Europe have transformed their American dependencies after the image of their mother-countries, and only he who leaves the cities far behind can forget that Mexico was colonized under the auspices of St. Jago and Ximenes.

This collection of "Summer-land Sketches" is, therefore, neither a record of a pilgrimage to the shrines and cathedrals of Spanish America, nor a bid for the patronage of Southwestern land-agencies, but rather a guide-book to one of the few remaining regions of earth that may give us an idea of the tree-land eastward in Eden which the Creator intended for the abode of mankind. In the terrace-lands of western Colima and Oaxaca, near the head-waters of the Rio Lerma and the mountain-lakes of Jalisco, and in the lonely highlands of Vera Paz, we may yet see forests that have never been desecrated by an axe, and free fellow-creatures which have not yet learned to flee from man as from a fiend.

AN ELEMENTARY TREATISE ON ANALYTICAL GEOMETRY, EMBRACING PLANE GEOMETRY AND AN INTRODUCTION TO GEOMETRY OF THREE DIMENSIONS. By EDWARD A. BOWSER. New York: D. Van Nostrand. 1880. Pp. 287.

PROFESSOR BOWSER has produced a very excellent text-book, and has successfully accomplished his object of presenting his subject in a clear and concise manner, suited to the ready comprehension of the class of students for which it is designed. The demonstrations have been selected with regard to their being of recognized excellence, from all available sources, and when a line of proof could be simplified it has been done.

THE MINOR ARTS. By CHARLES G. LELAND. London: Macmillan & Co. 1880. Pp. 148. Price 90 cents.

THE regard in which decorative work of all kinds is at present held has given a commercial value to many of those minor arts which have been heretofore viewed only in the light of accomplishments, and pursued only as a pastime. A large field of remunerative and agreeable employment is thus opened up to numbers of persons who could in no other way use their time and abilities to such advantage. These arts are mostly simple, and can be learned sufficiently well to enable the student to do at least passable work with a fair amount of diligence and at an inconsiderable cost. With the object of presenting such practical instruction in the use of the materials and the kind of work that can be made from them as the novice needs, in a convenient and easily accessible form, Mr. Leland has prepared the present little manual. The volume opens with a consideration of leather-work, of which there are three kinds, that known as *cuir bouilli*, in which the leather is softened and then molded, stamped, or otherwise shaped; sewed leather, and sheet-leather ornaments, such as leaves, flowers, etc. Mr. Leland devotes his attention chiefly to the first kind, which he shows is capable of producing in

a very simple way many elegant articles. In the chapter on porcelain-painting, the character of the pigments, the mode of drawing on porcelain, and the kinds of glaze produced are briefly touched upon. Simple instructions are given in the chapter on wood-carving, as also in the one on molding in plaster and gelatine. Other chapters treat of designing and transferring patterns, stenciling, mosaic-work, repoussé-work, and silver-chasing, and some minor manufactures not in themselves of sufficient importance to be given a separate place. The volume closes with a collection of useful receipts of cements, etc.

THE TEXTILE RECORD OF AMERICA. By James W. Nagle & John W. Ryckman. Published monthly at Philadelphia, $3 per year.

THIS is a handsomely printed thirty-six-page monthly journal devoted to the interests of those engaged in producing textile materials and in weaving them into fabrics. The first and second numbers, for September and October of this year, have varied tables of contents, and the journal promises to be very serviceable to the trade of which it is the exponent. It is under the editorial direction of Mr. Lorin Blodget, and is, like everything else published in Pennsylvania, thoroughly protectionist in creed. A department devoted to coloring-improvements, both in dyes and their use, is conducted by Dr. Alfred L. Kennedy.

DISEASES OF THE THROAT AND NOSE. By MORELL MACKENZIE, M. D. London: Vol. I. Philadelphia: Presley Blakiston. 1880. Pp. 570. Price, $4.

THIS is an American reprint of the valuable work of Dr. Mackenzie, of London, whose long experience and extensive acquaintance with diseases of this class eminently fit him to treat of them. The work is addressed to the profession, and is, as it professes to be, a systematic treatise upon the subject. The matter of this first volume is arranged under the three headings of "The Pharynx," "The Larynx," and "The Trachea." Under each the anatomy of the organ is first considered, next the instruments used in operating upon it, and the diseases to which it is subject, and the method of treatment. The complete work will be in two volumes, the second treating of the diseases of the œsophagus, nasal cavities, and neck. This volume is now in press, and will shortly appear.

MEMOIRS OF THE SCIENCE DEPARTMENT, UNIVERSITY OF TOKIO, JAPAN. Vol. III, Part I. Report on the Meteorology of Tokio for the Year 1879. By T. C. MENDENHALL. Published by the University. Government Printing-Office. 1880. Pp. 42.

THIS memoir comprises the meteorological observations made at the observatory of the University of Tokio during the year 1879. The results are tabulated, and numerous charts show graphically the variations in temperature, in barometrical readings, force of wind, etc. Professor Mendenhall does not consider that any general conclusions can be drawn from observations extending over such a brief period of time; but, as they are to be continued, the data will in time be collected from which such conclusions can be safely drawn. The observations of the barometer and thermometer were made three times a day, and those on the direction of the wind at more frequent intervals. They were made by Japanese under the direction of Professor Mendenhall, and every care has been taken to have them accurate. The volume is issued in excellent style, and is entirely of Japanese manufacture.

PUBLICATIONS RECEIVED.

L'Année Artistique (The Artistic Year). The Fine Arts in France and Abroad. By Victor Champier, Secretary of the Museum of Decorative Arts. Second Year: 1879. Paris: A. Quantin. 1880. Pp. 644.

Répertoire Politique et Historique (Political and Historical Repertory): containing a Political Review of the Year. Fourth Year: 1879. Published under the direction of M. Charles Valframbert, Doctor in Laws, Advocate of the Court of Appeals of Paris, Chevalier of the Legion of Honor. Paris: A. Quantin. 1880. Pp. 592.

L'Année Archéologique (the Archeological Year): Archeological Calendar, Centenaries, Review of the Year in France and Abroad. By Anthyme Saint-Paul. Year 1879. Paris: A. Quantin. 1880. Pp. 340.

Sugar Analysis: a Description of the Methods used in estimating the Constituents. By M. Benjamin, Ph. B. Illustrated. New York. 1880. Pp. 18.

Plan of the Cerebro-Spinal Nervous System. By S. V. Clevenger, M. D. Illustrated. Chicago. 1880. Pp. 39.

The Trenton Gravel and its Relation to the Antiquity of Man. By Henry Carvill Lewis. From the "Proceedings of the Academy of Sciences of Philadelphia." Pp. 16.

Notes on the Management of Orthopedic

Cases. By V. P. Gibney, M. D. Louisville, Ky. 1880. Pp. 9.

Perinephritis: Remarks on Diagnosis and Prognosis. By V. P. Gibney, M. D. Chicago. 1880. Pp. 30.

Science Education: an Address delivered at the Commencement of the Agricultural and Mechanical College of Alabama. By William Le Roy Brown, LL. D. Auburn, Ala. 1880. Pp. 16.

The Unification of Science. By Alfred Arnold. St. Augustine, Fla. 1880. Pp. 15.

On Rotting Wood. By Professor William H. Brewer, of Yale College. Read before the American Public Health Association, November 19, 1879. Pp. 3.

Culture of Sumac in Sicily, and its Preparation for Market in Europe and the United States. By William McMurtrie, Ph. D. Special Report No. 26, Department of Agriculture. Washington: Government Printing-Office. With 8 Plates. 1880. Pp. 18.

Tide Tables of the Pacific Coast of the United States. Pp. 63.—Tide Tables of the Atlantic Coast of the United States. Pp. 129. United States Coast and Geodetic Survey Office. Washington: Government Printing-Office. 25 cents each.

Quarterly Report of the Chief of the Bureau of Statistics, Treasury Department. Three Months ending June 30, 1880. Washington: Government Printing-Office. 1880. Pp. 92.

Medical Hints on the Production and Management of the Singing Voice. By Lennox Browne, F. R. C. S. Edin. New York: M. L. Holbrook & Co. Pp. 77. 25 cents.

The Devonian Insects of New Brunswick. By Samuel H. Scudder. Anniversary Memoirs of the Boston Society of Natural History. With Plate. Boston. 1880. Pp. 41.

A Text-Book of the Physiological Chemistry of the Animal Body. By Arthur Gamgee, M. D., F. R. S. With Illustrations. Vol. I. London: Macmillan & Co. 1880. Pp. 487. $4.50.

On Slight Ailments: their Nature and Treatment. By Lionel S. Beale, M. B., F. R. S. Philadelphia: Presley Blakiston. 1880. Pp. 353. $1.50.

A Manual of Classical Literature. By Charles Morris. Chicago: S. R. Griggs & Co. 1880. Pp. 418. $1.75.

The Ocean as a Health Resort. By William S. Wilson, L. R. C. P. Lond. Philadelphia: Presley Blakiston. 1880. Pp. 260. $2.50.

POPULAR MISCELLANY.

Lieutenant Schwatka's Arctic Journey.—The gap left in our knowledge of the ill-fated Arctic Expedition of Sir John Franklin, by the successive search-parties sent in quest of the explorers, has now been filled, as completely as it seems ever likely to be, by the remarkable achievement of Lieutenant Schwatka and his comrades, who have recently returned from their Arctic journey, after an absence of more than two years. Though the expedition was the poorest equipped of any of the similar ones which preceded it, it has accomplished more than any other, and that in the face of what would have seemed to less intrepid explorers insurmountable difficulties. The expedition of Sir John Franklin, consisting of the two ships Erebus and Terror, with a total party of one hundred and twenty-eight men, was sent out in the spring of 1845, and was never more seen. The mystery which enshrouded their fate was first unveiled by Dr. Rae, who, in 1853, found and brought to England a number of relics of the missing party, which are now in the British Museum. Dr. Rae's journey was made in the same general direction as that of Lieutenant Schwatka, but not over the same ground. Another expedition was sent out in 1858 under the command of Sir Leopold McClintock, who succeeded in obtaining the only written record that has been found. This showed that Franklin died on board ship in 1847, and the task of leading the way over the trackless Arctic fields, where the whole party perished miserably from cold and hunger, devolved upon Captain Crozier, the next in command. Franklin penetrated as far north as latitude 77°, going through Baffin Bay, Barrow Strait, and up Wellington Channel, but was forced to return southward, and in latitude 70° was frozen in by the ice toward the close of 1846. The vessels were abandoned in the spring of 1848, and the party, now consisting of one hundred and five men, betook themselves to the land in the hope of reaching some outpost of the Hudson Bay Company. They reached an island named King William Land, beyond which they never got. The subsequent expeditions of Dr. Kane and Captain Hall gleaned some further information, but there was still much to be learned of the way and place in which the party perished, and of what had become of the records which they must have had with them. It was to clear up these points that the Schwatka expedition undertook its perilous and fortunately successful journey, upon information regarding the existence of records which seemed reliable. This information was that one Captain Barry, of a whaler, while wintering in Repulse Bay, had been given a spoon by the Esquimaux, which had belonged to the Franklin party, and that this captain had subsequently overheard some natives talking, and learned that this spoon came from a cairn in King William Land where there

were others, as well as books and papers. When the expedition arrived at its destination at a northern point of Hudson Bay, this story was found to be without foundation. Lieutenant Schwatka, however, determined to make the trip to King William Land, in the hope of obtaining new information of value. The journey was in every way a formidable undertaking, having to be made on sledges, many hundred miles across a totally unknown country, which had to be depended upon for food. The party consisted of four white men and thirteen Esquimaux, provided with but one month's provisions, but also amply supplied with the best and most accurate American guns, to whose perfection, as it proved, they were indebted for being able to successfully accomplish the task. The party left their camp upon Hudson Bay, which they had named Camp Daly, on the 1st of April, 1879, and reached it again in March, after eleven months' absence, having traveled more than three thousand miles, and experienced a degree of cold that seems incredible. The lowest temperature was −71°, or 103° below the freezing-point, while the mean temperatures for the months of November and December, 1879, and January, 1880, were −49°, −50° and −53·2°. In such temperatures as these any object sears the skin as a red-hot iron, the slightest wind burns the face, and meat, hot from a boiling pot, freezes before it can be eaten. The story of the wanderings of the Franklin explorers, as learned by this party from the natives, and as confirmed by their personal search, is terrible in the extreme. These men were but a few hundred miles from waters frequented by whalers, and yet they all perished, and perished so as to leave hardly any evidence of their journey. So far as it could be traced, it was by Lieutenant Schwatka's party, and the bones that were found at different points along the desolate shore of King William Land were buried. Only one skeleton could be identified—that of Lieutenant Irving, and this was brought away by them. It was known by means of a medal found near by, which the natives, in their desecration of his grave, had forgotten to take. It was learned from the natives that one of the ships was sunk at a point about five miles west of Grant Point, near the Adelaide Peninsula. As the Esquimaux did not know how to get in by the deck, they cut a hole in the side on a level with the ice, through which they carried off what provisions and other things they could find, and in the spring, when the ice broke up, the ship sank. Across this Adelaide Peninsula, at a point named Starvation Cove, evidences were found that it was here that the last remnant of the party perished, and with them the records, Lieutenant Schwatka believing that they are irrecoverably lost. All the relics found here by the natives, as well as at other points, were destroyed, having been given to the children to play with, and in time were broken up and lost. Besides the knowledge gained of the Franklin party, the searchers obtained geographical results of value, and found a considerable error in the Admiralty chart, in the mapping of Back's River, which they found to extend a good deal east of south, instead of west of it.

The Marshall-Islanders.—A work recently published by Franz Hemshein, a resident German merchant and consul, on the language of the Marshall Islands, affords some interesting facts concerning this little Polynesian group and its people. The islands are of coral, and are called atolls, having for their foundation a ring-shaped coral reef on which a land surface has been formed of varying length, but only a few hundred yards in breadth, and rising but a few feet above the water-line. Channels through these banks connect the inclosed lagoons, which are seldom more than thirty or thirty-five fathoms deep, with the outer water. The channels are entirely wanting or are too shallow for ships in some of the islands. The thin soil supports a scanty vegetation, which is limited to only a few of the species peculiar to the South-Sea regions; but many useful plants have been imported from other islands and do well. The fauna is likewise insignificant, but has been increased by importations from abroad, along with which the universal rat has been introduced. The inhabitants are a small, slightly built people, who age early; the women have rounder faces than the men, with thin, fleshless hands, and begin to fade before they reach maturity. Four ranks are recognized among them. The

lowest are the Armidwon, or Kajur, who own nothing; above them are the Leadagedag, to whom they must bring provision, and whom they must obey. Men of the latter class are permitted to own property. The third rank, called the Budag, is composed of the brothers and sons of the king. Over all is the Irod, or king, from whom the Leadagedag receive their commands. The Kajurs are allowed to have but one wife; men of the other classes may have more. The Kajur has the right to take the single wife from a man of lower condition than himself, but the men of the second rank are not permitted to speak with the wife of the king; and if the king goes abroad, leaving his wife at home, all the Leadagedag and the Budag, except the sons of the king, must leave the island. If a woman in the higher ranks is put away by her husband, as may happen if she is childless, she can not be taken in marriage by any one of a lower condition; but a man may marry a woman of a higher rank than his own and be raised to her rank. The food of the islanders is scanty. Young cocoanuts take the place of the drinking water, which is brackish. Cocoa-nuts, pandanus, and bread-fruit form the regular food. Arrow-root, brought from the northern islands, cooked with finely cut cocoa-nut, forms a favorite dish. A kind of conserve is made by roasting the pandanus-fruit over a bed of hot coals and covered with hot sand. In two days the fruit is taken out, sliced, dried in the sun, and pressed into rolls, which can be kept for two years. Another preparation, piru, is made from the bread-fruit. The fruit is cut up, steeped in salt water, and beaten; it is then put away in a shady place and covered with leaves; the soft mass is kneaded on the second day, laid away for a week, and kneaded again, when it is ready for use, and will keep good for five or six months. The principal disease from which the people suffer, and the most fatal one, is a catarrhal cold resembling the glanders in beasts. Europeans are also liable to take it, but they have it in a milder form, and do not die of it. A skin-disease called the gogo is generally prevalent, but is not commonly dangerous. This disease is not due to lack of personal cleanliness, for the natives are so much in the water as to make such a condition rare, and it prevails chiefly with the men, who are most in the water. The guild of the heathen priests consisted chiefly of diviners. God was supposed to appear to them and disclose the future to them. During the interview, which usually lasted for two or three days, they took no food. They never ate or drank out of dishes that had been used, and broke the cups after they had drunken from them. They were supposed to know about the wind and the weather, and the chances of success in enterprises, and were called into the sick and expected to foretell whether they would live or die. Remedies for disease were and are wholly unknown. Warm water, a few leaves, and especially rubbing, which is carefully attended to by the women with conjuring words, are the only medicaments. The friends of the sick man were formerly accustomed to come to him, bringing pandanus leaves, which they would fold together in patterns of equal size; if the last fold came out of the same length with the others, the omen was considered a good one for an impending recovery; if otherwise, the sick man was taken away to a distance, depending on the length of the last fold. These and many other customs have gone or are going out of use, and occur only exceptionally in places where one tenth of the population have been converted to Christianity. Fights are rare; wars are carried on chiefly by one party trying to destroy the cocoa palms or burn the houses of the other. They never come to a battle, but are conducted by siege, and generally end by the besieged party yielding. The worst damage ensues after the war, when, the trees being cut down and the land wasted, a famine of five or six months' duration is nearly certain. The principal occupation of the inhabitants is fishing. To catch the flying-fish a large torch is burned in a dark night upon a fast-sailing canoe. The fish fly toward the glimmer and either strike the sail and fall down or are caught by the skillful fisherman with a long-handled net. The yellow-tail fish swims in schools, and is caught with two canoes which, tied together, draw a cord after them on the top of the water, and drive the fish into shallow places, where they are caught with little trouble. It is a curious fact that the fish will occasionally leap over the cord, but will never swim away under it.

Mats and hats are artfully woven out of the bark of a shrub called the loa, and colored in handsome patterns of yellow, red, and black. The natives formerly made numerous voyages to the islands of the whole Marshall group, and had charts of them, which were drawn and copied on sticks and stones.

Improvements in Electro-Motors and Dynamo-Machines.—In a paper recently read before the British Association, Mr. T. Weisendanger takes exception to some of the received theories regarding electro-motors and dynamo-generators, and points out an improved mode of construction for both. In regard to the relations of these two classes of machines, it has generally been held that the most efficient generator is also the most efficient motor. This Mr. Weisendanger considers erroneous. Dynamo-generators are efficient only when their field-magnets are able to retain at all times a certain amount of residual magnetism. Their cores are, therefore, usually made of hard cast iron, or, if of soft iron, they are attached to masses of cast iron so that these form part of them. None of the efforts hitherto made to construct dynamo-machines with soft-iron cores have met with success, and, as electro-motors to give the best results should have such cores, machines can not be made that will give the maximum efficiency in both kinds of work. The fact that the attempts to make dynamo-machines with soft-iron cores have resulted in failure, he considers, proves that the current theory of their action, viz., that the electricity is generated by the inductive action and reaction between the field-magnets and the armature, is inadequate. Even wrought iron contains some residual magnetism, and in large masses, and after it has been subjected to strong magnetization, the amount is considerable. By the theory, the smallest amount of such magnetism would be sufficient to start the action of the machine. Experiment, however, shows that this is not the case. Mr. Weisendanger does not offer a new theory, but insists that the present one needs to be amended to correctly express the facts. Attention is also called to the idea underlying the work of some recent experimenters, that the power of an electro-motor can be indefinitely increased by augmenting that of the field-magnets. This is characterized as a mischievous theory whose outcome is perpetual motion. The author, on the contrary, holds that there is a definite relation between the power of the field-magnets and the armature, which has yet to be experimentally determined. Assuming the relation of these sets of magnets to be one of equality, he has constructed a motor, in which the cores of the field-magnets are light pieces of soft iron, that gives very satisfactory results. Further experiments to determine the exact ratio of the power of the field and armature, he believes, will result in a much more perfect machine. The most novel and perhaps important part of Mr. Weisendanger's paper is that relating to the proper method of revolving the armature before the poles of the field-magnets. The present practice is to make the cores of the field-magnets and those of the armature of such shape that the circles in whose circumference they lie are concentric. The defect of this arrangement is, that the armatures approach the magnets through the space in which the intensity of the field is at a minimum. After the armature reaches the magnet, the distance between the two remains constant while they are passing each other. Mr. Weisendanger holds that in generators the strongest currents will be induced, and in motors the greatest amount of power obtained when the armature not only revolves in the most highly concentrated field, but when its entire motion is either one of approach to or withdrawal from the field-magnets. He, therefore, proposes that the field-magnets be set at an angle to the circle described by the revolving armature. This latter then approaches the former continuously to the very instant of its leaving them. The greater the number of magnets the more powerful the action, as the armature is throughout its entire movement either approaching or receding from the field-magnets. Mr. Weisendanger is very hopeful of the future possibilities of electricity. Our present machines he believes to be but very imperfect appliances, which further research may so improve that the electric current will eventually perform all the services now rendered by combustion. He

looks not only to electricity to furnish light, and, through the medium of present unutilized natural resources, motive power, but heat as well. The exhaustion of fuel-supply will inevitably drive us to seek and find some other agency to do our work, and this, he thinks there is good reason to believe, will be found in electrical energy.

A New Smelting-Furnace.—The utilization of petroleum for fuel in the various metallurgical operations, in steam generating, and generally where coal is industrially used, has been a favorite project with inventors for a dozen years or more. The advantages of such a fuel are very great, and the reward to the successful inventor of an apparatus that would make its use practicable would be correspondingly large. Like gas, a liquid fuel is under perfect control, and is in a form allowing of perfect combustion if properly burned. The fuel is, moreover, very abundant, the production having been for some time past in considerable excess of the demand. In one district alone something like six thousand barrels are daily running to waste through lack of storage capacity, and one of the largest producers of oil is now obtaining from the wells about fifteen thousand barrels per day more than can be marketed. The oil companies, as well as inventors who have hoped to make a fortune by a successful furnace, have been unceasing in their efforts to turn this fuel to industrial uses, but so far the devices—and they have been many—have uniformly failed. A furnace is, however, now being developed which seems to promise, if not a complete solution, at least a partial solution of the problem. The furnace consists, in reality, in an immense blowpipe-flame, which is made to play upon the ore to be smelted, when used for metallurgical purposes, and to pass through boiler-tubes when used for steam generating. In the metallurgical apparatus there is first a fuel-furnace in which any ordinary fuel may be used, or oil if preferred. Against the upper portion of the flame from this furnace a blast of air is projected, similar to that from the mouth blowpipe against the flame of a spirit-lamp. Into this blast, at the point where it strikes the fuel-furnace flame, a stream of oil is introduced. The on-going blast and the heat of the flame vaporize the oil, which is then in a condition to be completely consumed. The result of this arrangement is the production of a column of flame, some thirty or forty feet long, of high temperature. This flame is projected horizontally through an iron cylindrical shell, lined with fire-brick with a facing of graphite, into which the ore to be reduced is fed from a hopper at the farther end. The shell is slowly rotated, so that the entering ore, tumbling about, is brought into intimate contact with the flame. It is also slightly inclined, that the material may slowly feed into the flame, and the melted material run down into the crucible at the lower end, where it is tapped and the slag run off in the usual way. The farther end of the revolving cylinder is let into a chamber, built of brick, stone, or clay, which is divided into compartments by walls or sheets of incombustible material kept constantly wet by running water. The hot gases, carrying vapors of the metals and other ingredients of the ore, are here gradually cooled down and condensed, the character of the condensation depending upon the materials present in the ore. The burned gases are withdrawn from the condensing chamber by means of an exhaust-fan, and discharged into the atmosphere. The air and oil are both under perfect control, so that a heat suitable for smelting or for vaporizing can be produced at will. Several furnaces are shortly to be put into operation for the reduction of ores of the precious metals, on which experiments have so far chiefly been made. The inventor, however, expects to be able to use it successfully in making iron and steel, as well as in burning lime. A modified form is also suitable to the burning of pottery and glass-making. In using it for generating steam, the boiler-flue is made large, the flame at no point coming in contact with the metal, thus avoiding the burning out of the boiler, the chief difficulty encountered by most of the other devices using oil-fuel for steam-making. The experiments with the furnace upon an industrial scale have been as yet too few and imperfect to thoroughly test its value, but they seem to warrant the opinion that the furnace has capabilities that promise very well for its future usefulness.

The Markings of Meteoric Stones.—M. Daubrée, the eminent French geologist, in his recently published work on "Synthetic Studies in Experimental Geology," describes some experiments that he has made for the purpose of ascertaining the cause of the peculiar appearance of the surface of meteoric stones. These bodies are covered with a blackish coating, which is sometimes dull and sometimes brilliant, and indicates unmistakably that they have suffered modifications in passing through the atmosphere. Their fracture presents a globular surface, similar to the structure of terrestrial rocks, showing that a strong cohesion has been produced at the moment of their formation. The outer surface is also covered with rounded depressions forming little capsules. M. Daubrée had remarked that when a cannon loaded with coarse-grained powder was fired off, some grains, which were only partly burned, would fall at the muzzle of the piece. The hollowed surface of these grains bore a striking resemblance to the forms seen on the meteorites. He then performed an experiment by taking a rectangular plate of steel, rolling it up in such a way that it should be fully enveloped by the gases from the powder, putting it in a closed steel chamber, with a quantity of powder, and firing off the powder by means of the electric spark. The duration of the deflagration was less than half a second. The gases acquired a tension of from one to two thousand atmospheres, and a temperature estimated at about 3,600°. The action, though of very short duration, gave surprising results. The surface of the plate was hollowed into irregular furrows, which demonstrated the force of the gaseous currents, and a powder of sulphuret of iron was found in the bottom of the vessel. A half a second, then, was all the time that was required to produce a partial fusion of the steel, a considerable blowing up by the gases, and such a chemical action as the formation of a sulphuret of iron. The experiment was repeated with dynamite and other explosives, with identical results. From them, M. Daubrée has deduced the following interpretation of the meteoric phenomena: the meteorites enter the terrestrial atmosphere with an enormous swiftness. The great pressure of air to which they are subjected explains the incandescence which takes place, and the superficial fusion of the mass. The part of a projectile of this kind which is at the moment in front rams the air and compresses it exceedingly, and causes it to be agitated by energetic gyratory movements. In whirling thus, under such pressure, the air tends to screw and hollow out whatever it rubs against, and this mechanical action is accompanied and reënforced by a chemical action due to the combustible nature of the meteoric rocks at these high temperatures. These rocks contain enough particles of iron in the native state, or as a sulphuret, to largely favor combustion and disaggregation. Under these circumstances, the hollows are produced, which appear on one side or on all sides of the projectile, accordingly as it has not or has a motion of rotation. M. Daubrée has given to these hollows the name of *piezoglyptes*.

Relation of Age and Marriage to Suicide.—It has been a mooted question whether the old or the young were more prone to suicide. Statistics published by Dr. Bertillon, in an article on marriage in the French "Encyclopædic Dictionary of the Medical Sciences," prove that the propensity increases with advancing age. They are reënforced by statistics recently published in Sweden, which lead to substantially the same conclusion. The proportion of the number of suicides of the more advanced ages to the whole number of persons of corresponding ages appears to be less in Sweden than in France, but aside from this the proportion increases regularly in both countries from the age of fifteen or twenty years to that of sixty years. After about sixty years the tendency in both countries appears to diminish. The proportion of suicides among women is less at all ages than among men, but increases with the advance of years as with the men. The statistical work of Signor Morrelli, recently published at Milan, lends additional support to these views. Dr. Bertillon has also collected facts bearing on the effect of marriage upon the tendency to suicide, from which he has deduced the principles: 1. That widowers and widows commit suicide more frequently than married persons; and, 2, that the presence of children in the family makes the probability of suicide more re-

mote. The salutary influence of children is equally marked with married and widowed persons, with men and women. The Swedish statistics may be brought in again to enlarge our knowledge on this point by showing the combined influence of marriage and age. According to these tables, the difference in the liability of married men and celibates, while they are still young, is very slight. The tendency to suicide then increases slowly among married men as they grow older, and at its maximum (at about sixty to sixty-five years of age) is two and one half times (26 in 100,000) what it was at the adult age (10 to 11 per 100,000). After the sixty-fifth year it diminishes. With unmarried persons, on the other hand, the tendency increases with almost a geometrical progression. At twenty-five years of age it is more than double (26 per 100,000) what it is with married persons of the same age (11 per 100,000), and at seventy years is eleven times as great (230 against 21 per 100,000); and after this period it goes on increasing as fast as ever, while the proportion for married persons is diminishing. The phenomena with women are analogous, but less marked. It is found, by comparing the statistics of the two classes, that the general increase in the tendency to commit suicide with advancing age can be almost wholly accounted for by this progression of suicides among the unmarried. The difference in the liability of the two classes may be partly explained by setting off the regularity of habit which married life and particularly the care for children induce with the irregularities to which the unmarried surrender themselves, of which the most damaging is drunkenness. Signor Morrelli says that drunkenness causes thirty-one per cent. of the suicides in Denmark, and that a similar rule prevails everywhere.

Artificial Lights.—The great point of difference between natural and artificial lights, says Dr. Javal, the French occulist, is the excessive feebleness of the latter. A lamp or a gas-jet makes an insignificant impression in daylight. The light of a million candles burning in a room would be vastly inferior in intensity to that of the direct rays of the sun. The pupils of our eyes are considerably larger in the most brilliantly lighted room than they are in daylight. We seek the brightest places of resort at night, and use the strongest lights we can afford in our homes, employing every means to make them stronger. Persons with imperfect sight are fatigued in working with artificial lights because the enlargement of their pupils gives full play to faults which are mitigated under the contraction of the aperture which a strong light induces. The spectra of all artificial lights, except the magnesium and electrical lights, are different from the spectrum of sunlight in that they are dark on the most refracted side, that of the blue, violet, and chemical rays. It may be that this quality compensates in part for the greater dilatation of the pupil which these lights require by reducing the amount of chromatic refraction which would otherwise take place. It does not appear, however, that any workmen prefer such lights to sunlight. It has been suggested that the presence of these rays in the electric light might cause it to be injurious. If that should prove to be the case, any evil effect might be remedied by shading the pencils with yellow-tinted globes. No complaint has been made, however, of bad effects arising from the proper use of this light. Those who have studied it most attentively have felt no inconvenience except when they looked intently at it without guarding their eyes. It is not intended to be used thus; and, if we judged by this criterion, the sun would be the worst of all lights. When the electric light was first introduced into the freight depots in Paris, the workmen complained of being dazzled by it. After some weeks, it was taken away, and gas was put in its place, when a general outcry went up against the darkness.

A Solar Machine.—The idea of applying the heat of the sun directly as a motive force has been entertained as within the limits of possibility for some time. A Frenchman, M. Mouchot, devised a machine, about two years ago, for concentrating the rays of the sun so that they could be made to perform some slight offices. M. Abel Pifre, an engineer associated with M. Mouchot, has carried on some experiments in Algeria with an adaptation of his machine which have had a promising degree of success. His apparatus

was small, yet it was sufficient, by the aid of the sun of last October, to produce steam enough to keep a sewing-machine in continuous motion, cook food, and boil water. M. Mouchot's machine consists of a reflector in the form of a truncated cone, which concentrates the rays of the sun upon a kettle placed in the axis of the cone, with a bell-glass to cover the kettle and protect it from external cooling. Such machines are not likely to be of much practical use in temperate climates, where the sun is comparatively weak and often clouded; but in hot, arid regions, like the deserts of Africa, they may possibly yet be employed advantageously.

Consumption and Climates.—Dr John C. Thorowgood, of the London Hospital for Diseases of the Chest, in a paper on "Atmospheric and Climatic Influence in the Causation and Cure of Pulmonary Disease," distinguishes between two classes of phthisis, or consumption of the lungs, in which the operation of this influence is very different. The first kind, the consumption which originates in catarrh, cold, or some inflammatory attack, prevails in raw, cold climates, and is relieved by going to a mild climate. The second kind, true tubercular consumption, comes on insidiously, often from no cold caught, from no privation of food, but simply from some inherent, perhaps hereditary vice in the system, and is a febrile disease, having much the character of rapid blood-poisoning. It is not peculiar to cold climates, and is not relieved by sending the patient to a mild one. The worst that can be done in cases of either form of disease is, to confine the patient closely to one room, and let him breathe over and over again the same atmosphere, while the cough is kept checked by opiates. In this way, says Dr. Thorowgood, consumption may be cultivated and developed from the first class into the more serious form of the second class, so that it becomes a fearfully destructive malady. "In the cases of young children who are kept very close in heated rooms, and who are said to be always taking cold, we often see most obstinate cough and catarrh, due to the throwing off from the air-passages of a weak, poorly-nourished epithelium, which in time may choke the air-cells, and so lead to pulmonary consumption. The cure consists in laying aside paregoric and squills while we feed the epithelium with pure air. Appetite soon returns, and the cough speedily takes its flight." The tendency of confinement in a close atmosphere to cause blood-spitting and consumption has been demonstrated by the statistics obtained by Dr. Gray when engaged in investigating the effects of certain trades on the health of those employed. The author of the paper under notice has seen excellent results, in removing lingering inflammation after an acute attack on the chest, follow a sojourn at Torquay, Ventnor, and similar mild, warm health-resorts; but when the disorder has passed from the inflammatory stage to one that involves the general nutrition, and is marked by softening and breaking down of lung-tissue, with night-sweats and copious purulent expectoration, he has never seen any good come of a residence in a mild, sedative climate. On the other hand, he tells of several cases in which persons suffering from the latter form have been relieved, and have even recovered after being sent to a cold, bracing climate, or to a high mountain elevation. The author's views were confirmed, in the discussion by the medical society before which it was read, by several speakers. The president of the society mentioned three cases of complete cure of decided pulmonary consumption of non-catarrhal origin by change of air—in one case to Moscow, in two others to Canada. Another speaker mentioned cases of catarrhal phthisis that had been cured by sojourn at mild resorts.

Effect of Physical Training on Respiration.—M. Marey has made an investigation of the modifications which are induced in the respiratory movements by the fact of muscular action. It is well known that muscular action provokes, in those who are not accustomed to it, panting, that is, a respiration stronger and more frequent than the normal respiration. This is in consequence of the greater rapidity of the current of blood which in its abundance demands, in order to pass through the lungs, more frequent or more ample respirations. The habit of muscular exercise, running, for example, has the effect of gradually adapting the respiratory function to the most rapid cir-

culation which can pass the lungs. The respiratory type acquired by the gymnast consists in an enormous increase in the expansion of the chest and a notable retardation of the thoracic movements. M. Marey and Dr. Hillairet selected five recruits and registered the rate of respiration of each of them when at rest, and again after they had run a course of six hundred metres at the gymnastic pace. By following the changes of respiration of these gymnasts from month to month, a series of curves was obtained, and the following results were furnished: At first, respiration was very perceptibly modified by the running; but toward the end of the experiments, that is, after four or five months of the exercises, it was almost impossible to distinguish any change in the respiration of the men who had run; and this, notwithstanding their gait had become a little more rapid, and they ran over the six hundred metres in three minutes and fifty seconds. The figures show that the modification of the respiratory movements is permanent—that is, that it is maintained when the man is at rest. The number of respirations is reduced, in the mean, from twenty to about twelve in a minute, and their amplitude is more than quadrupled. We may conclude, then, that these soldiers, after having experienced the effects of gymnastic training, breathe about twice as much air as before they were subjected to the discipline.

Expectant Attention in Animals.—A remarkable instance of sagacity in animals is described in an article on "Mental Physiology" in a late number of the "Edinburgh Review," in the case of a dog that belonged to Professor Huggins. This dog, Kepler, had the faculty of answering correctly with his barkings arithmetical questions, including such problems as giving the square root of nine or sixteen, or the result of adding seven to eight, dividing the sum by three, and multiplying the quotient by two. No power of calculation was implied in this exercise, or operation of the understanding, however it may have seemed. The case was simply one of what is called by physiologists expectant attention. A clew to the process is given by the statement in the story that, until the solution was arrived at, Kepler never moved his eye from his master's face, but the instant the last bark was given he transferred his attention to the cake which was always held before him as a reward for a successful performance. Professor Huggins, the writer continues, was perfectly unconscious of suggesting the proper answer to the dog, but it is beyond all question that he did so. The wonderful fact is, that Kepler had acquired the habit of reading in his master's eye or countenance some indication that was not known to Professor Huggins himself. Professor Huggins was engaged in working out mentally the various stages of his arithmetical processes as he propounded the numbers to Kepler, and, being aware, therefore, of what the answer should be, expected the dog to cease barking when the number was reached; and that expectation suggested to his own brain the unconscious signal which was caught by the quick eye of the dog. In an analogous manner, a person swinging a button by a thread near the rim of a glass will unwittingly cause it to strike the hour, if he knows the hour, through the unconscious control of his brain over the movements of his finger.

Change as a Mental Restorative.—Dr. Joseph Mortimer-Granville, discussing in the "Lancet" the subject of "Change as a Mental Restorative," shows that great discrimination is needed in prescribing this remedy. Some patients there are, such as those who have become wearied with a purposeless life or one of idle dissipation, who have become worn out with change, and to whom a prescription of it for its own sake, without consideration of the circumstances, would only impose an additional infliction. They are most difficult cases to deal with, and demand especial study. The change which a person of this kind requires is "one that will stir a deeper spring of energy than has yet supplied him with motive-force, by compelling his recognition of the responsibilities of life. It is idle to hope that he can be roused to action by the discovery of a new pleasure. . . . The energies of such a character are more likely to be called out by pain and necessity than by pleasure and satisfaction." Some men of pleasure have been delivered from the extreme of *ennui*, which they had reached, by the loss of for-

tune bringing pressing need for exertion; but this remedy is beyond the reach of a physician. He might aim, however, to supply an incentive to action by searching for "some inherited seed of ambition or enterprise which has never yet germinated," and may sometimes find it by learning the story of the father's or grandfather's life. A case which came under Dr. Granville's care, and which furnished him with the basis for his remarks on this subject, was cured by the awakening of a strong passion for the breeding of stock, which he had inherited from his grandfather, but which had not been aroused in his nature till he was thrown into circumstances which excited him to emulate the success of a neighbor. A similar case, where no such awakening of energy occurred, ended in suicide.

The Mirage on Swiss Lakes.—Professor Charles Dufour communicated to the French Association, at its last meeting, a paper on the mirages of the Swiss lakes, which are often seen between the month of August and the spring, especially in the morning, when the water is warmer than the air. When Monge published his explanation of the mirage, he supposed that the strata of air near the ground were warmer and rarer than the strata above, but he could not prove it experimentally. Professor Dufour has proved it by taking the temperature at different heights above Lake Leman, while the sun was still hidden by the mountains. The mirage frequently produces curious illusions. When a boat is near the point where the ray of light is a tangent to the surface of the water, the mirage of the sky is thrown below the boat, and the latter seems to sail in the air. Seen from Villeneuve, the steamboat plying between Montreux and Vevay seems to be sailing among the vineyards which cover the hills along the shore. When the air, on the other hand, is warmer than the water, as is the case generally in the spring and summer on fine afternoons, the concave side of the refracted ray of light is turned toward the water, and objects are brought into sight which are really hidden by the roundness of the earth. Sometimes the temperature of the different strata of the air varies irregularly. Then the rays of light undergo abnormal refractions which are not always the same for the upper and lower parts of objects. Consequently, the objects are sometimes diminished, sometimes magnified in an extraordinary fashion. Small houses thus distorted are made to look like palaces; their white color is changed into gray by the diffusion of the light, and they are thereby given an air of greater grandeur. Many persons fail to take notice of these mirages because they regard them as reflections from the water; but it is really possible for one with his eye near the water to see the reflection from it of a distant object on nearly the same level. When an image of such an object is seen, it is most probably a mirage.

Variations in the Fixed Points of Thermometers.—M. Crafts, in the course of his investigation of the causes of the variations of the fixed points of thermometers, has discovered that glass heated for a long time in the blowpipe-flame shrinks in consequence of an internal change. It is not shown that pressure plays any part in the phenomenon. The particles of the glass which have been separated by the heating do not return to the normal position immediately on cooling, but appear to be in a disturbed condition for some time afterward. The action of heat at a given temperature, say of 670°, by giving a greater mobility to the particles, favors their return to the normal position; but the glass, in cooling from this temperature, retains a part of the expansion which it has undergone. By heating it anew to an inferior temperature, say 570°, we may produce a new diminution of volume, and thus successively, by a very slow process of cooling, bring about the greatest approximation to the normal state, and consequently the greatest stability. The law discovered by M. Pernet for temperatures between the freezing and boiling points of water, according to which the depressions of the freezing-point are proportional to the squares of the temperatures, is not true at high temperatures. A thermometer, for example, which gives a depression of half a degree after a long exposure at 212°, ought, by this law, to give at 670° a depression of 6.8°. The depressions actually observed are much less considerable.

The Deep Valley of the Caribbean Sea.—Commander J. R. Bartlett, of the Coast-Survey steamer Blake, has ascertained some interesting facts in regard to the depths of the western part of the Caribbean Sea. The data he has obtained make it probable that a large portion of the supply for the Gulf Stream passes through the "Windward Passage" between Cuba and San Domingo, and that the current extends in it to the depth of 800 fathoms. The temperature, of 39½°, which was indicated at all depths below 700 fathoms in the Gulf of Mexico and the western Caribbean, was not obtained here. Elsewhere, in these seas, the temperature decreased from the surface to 39½° at 700 fathoms or less, and remained constant at that temperature for all lower depths. At greater depths than 600 or 700 fathoms the bottom was always found to be a calcareous ooze composed of pteropod shells with small particles of coral. An immense, deep valley was found to extend from between Cuba and Jamaica to the westward, south of the Cayman Islands, well up into the Bay of Honduras. It has a length of 430 miles, and a general breadth of 105 miles, with a depth nowhere of less than 2,000 fathoms, except at two or three points where the summits of submarine mountains rise to near the surface. Within 20 miles of Grand Cayman it attains an extreme depth of 3,428 fathoms; this island is therefore, to the bottom of the valley, as a mountain 20,000 feet high, and Blue Mountain, in Jamaica, rises 29,000 feet above the bottom, or as high as the highest of the Himalayas is above the level of the sea. The deepest part of the valley has been named the "Bartlett Deep."

NOTES.

Mr. Rogers Field, in a recent lecture on house-drainage at the Parkes Museum of Hygiene, condemned all forms of water-traps as a means of excluding sewer-gas from dwellings, on the ground that they allow the gases to pass through them by the water absorbing it on one side and giving it off on the other. In his opinion, the only sure way to keep these gases out of the house is by thorough ventilation and disconnection. Efficient ventilation means a continuous current of fresh air through the drains and pipes, but even then perfect security can only be obtained by cutting off direct communication between the sewer and the house-drains.

The last annual report of the New Haven Board of Health contains a valuable letter addressed to the Common Council of that city, by the President of the Board, Professor William H. Brewer, of the Sheffield Scientific School, setting forth in a forcible way the financial advantages of a thorough system of sanitary administration in towns and villages. This letter should be in the hands of all the village trustees in the land, many of whom may be reached by money considerations when mere questions of life and death would scarcely arrest attention.

In its crusade against the London shopkeepers for obliging their saleswomen to stand continually during business hours, the "Lancet" is disposed to lay a part of the blame on the patrons of these establishments. It thinks if there were any real sympathy, on the part of the public, for the young persons who are made to suffer by the system of standing, it would long ago have been brought to a summary close. We sometimes hear of women having a special faculty for nursing the sick: they should show in this matter that they have the humanity to avoid the creation of needless disease.

Mr. Nilson has prepared a quantity of the oxide of the new metal ytterbium, or ytterbine, and finds the atomic weight of the metal to be 17·301. Ytterbine appears in the state of an infusible white powder of a density of 9·175, insoluble in water, but easily dissolved in acids, even when diluted, at a boiling heat; but, when cold, they attack it with difficulty, even if concentrated. The solutions are colorless, and show no absorption rays in the spectrum. The earth and its salts do not communicate any color to flames; but the chloride gives a very bright spectrum with the electric spark.

A new remedy for neuralgia has been introduced into England from the Feejee islands. It is called *tonga*, and is brought in the shape of fragments of woody fiber, bark, and leaves, broken up into pieces so small as to make it hard to identify them botanically, mixed and done up into balls of about the size of an orange. To prepare it, the ball is soaked in cold water for about ten minutes, when the infusion is drawn off and a claret-glass of it is taken three times a day. The ball is then dried and hung up, and can be used over and over again for a year. The principal constituent of the remedy appears to be the stem of a species of *Raphidophora*.

M. Lortet, who has been studying the fauna of the Lake of Tiberias, reports that

its surface is 212 metres (689 feet) below the level of the Mediterranean, and that its greatest depth, which is at the northern extremity opposite the upper mouth of the Jordan, is 250 metres (812 feet). On both shores of the lake are terraces covered with rounded pebbles, rising to a height which indicates that the level of the lake was once the same as that of the Mediterranean. He believes that the waters of the lake were formerly very salt, more so than sea-water, but not so excessively salt as the waters of the Dead Sea, and that they have been freshened since the level of the lake was lowered by volcanic convulsions, by the flow of the Jordan, till they have become drinkable.

PROFESSOR SCHNELTZLER, assuming that the color of flowers is due to the combination of different chemical elements in their tissues, has shown by experiment that when an alcoholic extract of the color is made it is enough to add to it an acid or alkaline substance to cause it to exhibit any of the colors which plants present. Flowers of the peony, for example, give a violet liquid in alcohol; if salt of sorrel is added to this liquid, it will turn a pure red; soda produces, according to the quantity that is added, violet, blue, or green.

THOSE in pursuit of the marvelous may learn a grain of caution from the following, taken from an article on "Living Toads in Stone" by Mr. Thomas G. Denny, in a recent number of "Science Gossip": "Most of us have heard of 'Flint Jack,' but I do not think many readers of this journal have met with any manufacturers of fossil toads; but I knew many years ago a working naturalist living in Leeds who used to prepare for sale toads, stated to have been found in beds of coal, by baking them perfectly black and hard in an oven, and then taking square pieces of coal and, after splitting them carefully, he would cut a hollow in each portion to receive the 'ancient reptile.'"

MR. FREDERICK RANSOME has succeeded in producing a good hydraulic cement from the slag of blast-furnaces. His process, which is applicable to almost any quality of slag, has the advantage over previous methods of making cement, that while in them the materials, lime, silica, and alumina, had to be brought together and carefully combined, in blast-furnace slag the combination has already been completely effected before the slag has left the furnaces, and generally with the proportions of silica and alumina that are required. By mixing the slag with an additional quantity of lime and calcining the mass, a strong and reliable cement of an agreeable color is produced.

IT has been affirmed, in proof of the theory that fat is formed from albumen, that the albumen of the cheese in the cellars of Roquefort is changed to fat by the action of a fungus found there. The assertion is disproved by experiments made by Herr Sieber on the cheese in these cellars, which show that the most marked change that cheese undergoes in ripening is the loss of water, and that the proportion of fat remains unaltered if only the dry substance be considered. A decomposition of the albumen also takes place, the caseine passing into a series of decomposition-products which are similar to products of putrefaction in the first stage of putrefactive fermentation, but the analyses show no transformation of albumen into fat.

EFFORTS to reduce monkeys to discipline have not very often been successful. A native of the province of Bengal has, however, trained several of them to work the cords by which the *punka*, or ventilating fan of India, is moved. They perform their task to perfection, and, thanks to their activity, keep the *punkas* in continuous motion, maintaining a constant, agreeable movement of air all through the room.

DR. HENRY BARNES records a case of an extremely severe attack of gout brought on by sleeping in a newly painted room. Three years before, the patient, an old man, had suffered a slight attack of the disease (the first of his life), but soon recovered, and, up to the time of this exposure, had been quite free from gouty symptoms. The introduction of lead into the system is given as the cause of the attack.

A COMPANY with large capital has been formed in Paris to work up an invention for coating thread with silk. The invention embraces, according to the "Bulletin des Soies," a chemical process for covering linen or other vegetable threads with a mesh of silken matter in a manner similar to that in which metallic objects are plated with gold or silver. The process is dependent on the fact, which has long been known, that silk is soluble in several strong acid preparations.

THE French Chamber of Deputies has voted a credit of fifty thousand francs to M. Pasteur to enable him to extend his researches upon the contagious diseases of animals. The labors of M. Pasteur during the last four years have already led to the discovery of the causes of carbonaceous affections, and the knowledge thus gained has been employed to prevent them in many cases. His present investigations are in relation to the character of virulent maladies in general.

ALBERT J. MYER.